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**Electric Lighting in New York.**

ELSEWHERE in our columns we give a little sketch of the present state of electric illumination in this city. Its growth during the last decade has been enormous, yet accomplished so gradually and quietly that it is hard to realize how great it has been unless one deliberately stops to take account of the actual state of things prevailing at present. The figures show that in spite of the war upon overhead wires and the great difficulties encountered in getting proper subway accommodations New York is to-day the most thoroughly illuminated by electric light of any city in the world. In other places arc lights may be more numerous, but the difference is more than compensated by the enormous amount of incandescents in use in this metropolis. And the work is not even now nearing completion, for there remain opportunities not only for immense extension of service uptown, but for the more general distribution of light through the lateral strips that touch the two great rivers of either side of Manhattan Island.

**A Standard of Light.**

WE are pleased to note that active steps are likely to be taken abroad for attacking the question of a standard of light. The London Board of trade has inaugurated the movement, which is primarily with reference to testing the gas supply of London, but in a secondary way may involve a much more general application. It is highly desirable that there should be some exact and generally employed standard of illumination. It is unfortunately a difficult matter to find one which will fulfill the varied duties required of it. Standards of mass and length can be easily duplicated with a high degree of accuracy, and remain to all intents and purposes unchanged, when carried to all parts of the world. A standard of light, however, that depends on thermal action which cannot be kept constant, is not easy to duplicate. The last one proposed is, as will be remembered by many of our readers, the light emitted from a square centimetre surface of platinum at its melting point; such an idea, although scientific, remains peculiarly inconvenient for practical use in spite of the very many ingenious efforts that have been made to reduce the experimental sources of trouble. The Methven screen is used to a considerable extent, but even now much of the testing of illumination falls back on the old standard candle, which, despite its imperfections, is remarkably convenient, and, considering its character, surprisingly good. Nevertheless, something better than any of these is much needed, and if the committee about to be appointed can evolve an everyday working standard of light, easy of duplication, convenient to apply, it will have done very material service both to science and the practical art of illumination.

**The Trolley System for Brooklyn.**

IN our last issue we briefly noted the victory that the trolley system has won in Brooklyn. It is a matter of congratulation that the numerous obstacles thrown in the way of electric rapid transit in that city have at last been overcome, and that another season is likely to see an improvement the magnitude of which the Brooklynites can hardly realize. But the adoption of the trolley system on the extensive surface lines of that city has a deeper meaning than mere increase of the extent of electrical traction in America. It shows that to a certain extent public prejudice against the use of the overhead electric railway in large cities has been overcome, and, furthermore, it is highly probable that the initiative taken by Brooklyn will be followed elsewhere. The development of electric railroading in and about New York City has suffered greatly from there being no large and successful road in operation near by, from which the merits of our modern substitute for the horse could be properly judged. Now, however, the general public will soon have an opportunity to become acquainted with the facts in the case, and we shall in all probability hear less and less nonsense about the "deadly trolley." The solemn truth to tell, the objections to overhead lines are mainly æsthetic ones, and though these may have a real existence they do not afford an adequate reason for condemning the public to slow progress by horse, or the street railway owners to the costly and dangerous cable system. The success of the electric road in Boston has given plenty of evidence as to the excellent results that may he hoped for in Brooklyn, but there is every reason to suppose that with the experience of Boston before them the owners of the Brooklyn street railway system will develop it into an electrical road superior in economy and general efficiency to anything that has yet been attempted. In addition, the coming rapid transit in Brooklyn will afford an excellent opportunity for New Yorkers to compare it with the two cable roads that will go into operation during the next season. It is highly probable that the cry of the daily press after a short period of observation will suddenly be changed and it will be the order of the day to indite savage jeremiads against the "deadly cable."

**Edison's Plan for Rapid Transit.**

ON another page will be found a very interesting note taken from the *Edison Monthly Record*, the official organ of the Edison company, regarding the remarkable plan for electric rapid transit in cities, which was devised by Mr. Edison, and caused so great an amount of varied comment during the past few weeks. It is the first authoritative statement of facts that has been made public, and as such is of particular importance. Immediately the original announcement of this system was made the news of it spread over the country like wildfire, and it became somewhat difficult to get franchises for overhead lines, on the ground that Edison's new invention would render such lines needless and objectionable. An official explanation of the real character of the proposed system is therefore very timely and wise. It proves to be what we have already substantially indicated in these columns more than once; the only additional facts brought out are, that the car motors are to be wound with bare copper bars, and a definite statement of the voltage to be employed on the primary circuit. Mr. Edison does not propose to introduce his low voltage distribution for general use, but only for large cities where its considerable cost would, on account of the heavy traffic, constitute no very serious objection to its use. Few details of the plan are given in the article in question, which is a pity, as the solution he has obtained of certain of the inherent difficulties would doubtless be of great interest. The nature of the contact apparatus, which must pick up from the track some 500 ampères, and the method of producing rail joints for a similar current are certainly topics upon which electricians are most anxious for information. The low pressure will undoubtedly reduce the leakage to a comparatively small amount, but whether 20 volts is low enough to avoid the danger of shocking horses may be regarded as somewhat doubtful. The horse is apparently peculiarly sensitive to electric currents, owing probably to his iron shod feet with nails penetrating deeply into the hoof. It would not be surprising if 20 volts difference of potential between the rails might cause some strange antics on the part of the equine population of New York. We sincerely hope that Mr. Edison's preparations for carrying out the arrangement on a considerable scale will be pushed rapidly forward, for a working road of this character would be—whatever its success—a most valuable study in the methods of electric traction.

**Magnetic Leakage.**

ON another page will be found a very careful study of the problem of magnetic leakage. The general features of the subject have long been known, but Mr. Ives, the author of the present paper, has made the interesting discovery that the leakage coefficient of a dynamo can be measured with great exactness, and very easily, by utilizing an ordinary Weston voltmeter instead of the cumbersome ballistic galvanometer which has generally been employed for the purpose. The fact seems to be that even if the dead beat instrument does not successfully integrate the variable current impulse, it at least does integrate, in studying any given dynamo, a very nearly constant proportion of it, so that the comparative results are almost exact. In fact measurement of the leakage of the same machine by a voltmeter and by a true ballistic galvanometer gave results concordant within a very small fraction of one per cent. The machines studied by Mr. Ives varied considerably in size and character. They were five in number, two of them Crocker-Wheeler motors of one-sixth and 3 h. p. capacity respectively; a 400-light "Standard" multipolar dynamo; a 400-light Edison dynamo, and a 100-light Fort Wayne alternator of a special type. The coefficient of leakage found varied in these machines very widely; the best result was given by the Crocker-Wheeler 3 h. p. motor. The leakage co-efficient in this case was 1.21, showing a strikingly small amount of waste field, the result of small air gap, careful construction of magnetic circuit, and, also, the fact that the pole pieces and magnetic cores are drop-forged in a single piece. The smaller motor gives a less favorable result, but still has a leakage coefficient of only 1.4. Another machine which gave an unusually satisfactory figure was the multipolar "Standard" dynamo. This is a machine which is not nearly as well known as it deserves to be. It is a six-pole dynamo with a Gramme armature, wound in slots with bare copper wires. Its efficiency is high and its weight efficiency phenomenal. It would be at the start expected that there would be considerable magnetic leakage. As a matter of fact the coefficient is only 1.32 between the magnetism in the field and that in the armature, a result which is assuredly largely due to the toothed construction and the very small air gap consequent upon it. The advantage of the toothed over the smooth armature in this respect is strikingly shown by the tests that were made on the Edison machine of just the same voltage and capacity as the "Standard" and of high efficiency. The leakage coefficient, however, was no less than 1.66. Part of the rather large waste field is undoubtedly ascribable to the leakage through the base of the machine, but the smooth armature and the consequent wide air gap is undoubtedly responsible for the major portion of the loss. The alternator gave a better result than was to be expected, the leakage coefficient being only 1.39. The effect of this leakage on the actual working efficiency of the dynamo is not very considerable, amounting to only two or three per cent. at the outside, but its indirect effects are sometimes serious in causing disturbances of instruments in the vicinity, including watches, and sparking. In the various types of commercial machine the leakage coefficient—as will be seen from Mr. Ives' paper—varies considerably, and probably the lowest value given is lower than is usual, while the highest figure more nearly represents ordinary practice. The erect U-shaped magnetic field magnet seems particularly favorable to escaping serious leakage, while the old Ball arc light dynamo, with its widely separated pole pieces and two armatures, probably exceeds any of Mr. Ives' figures by a considerable amount. The Thomson-Houston arc dynamo, too, is possessed of a phenomenally large leakage coefficient—as high as 1.9 in some of the earlier machines. Probably the majority of the dynamos in every day use have a leakage coefficient greater than 1.5, and do not suffer very seriously from it. With proper design of pole pieces so that there is no serious sparking from a stray field, the waste magnetism is an unimportant factor in the general usefulness of a dynamo, except in that it causes an unnecessary increase of iron and wire in the field coils. It would be a matter of considerable interest if some student of electro-technics would take up this work of Mr. Ives, and utilizing the very simple method he has pointed out would extend the research through all the familiar forms of dynamos. Such a collection of data would be very useful, and could be obtained with very little trouble, as the readings by means of a voltmeter can be taken very rapidly.

## Latest Foreign Electrical News.

*(By Cable from Our Own Correspondent.)*

London, Dec. 28, 1891.—The preliminary borings to determine the character of the underlying earth along the route of the Central London Railway about to be constructed showed a very satisfactory condition of things, and the work will probably not be difficult.

As I mentioned last week there was at Lloyd & Lloyd's Works at Birmingham a thorough test of the improved Bernardos process for electric welding; the results were very encouraging and will doubtless further the introduction of the process.

A few days since the Birmingham electric road, opened some weeks ago, was treated to its first collision. Two cars ran into each other without, however, anything serious happening. The cause was a dense fog that has prevailed almost throughout England of late.

The St. Pancras municipal station has been accorded an unusual degree of success, for although it only went into operation on the 9th of November there are already 10,000 lights connected and more to come.

## Not to Supersede the Trolley.

There is no item of so much interest in connection with the recent discussion as to Mr. Edison's proposed street railway system without trolleys as that which appeared in the Edison *Monthly Record* for December, which is the official organ of the Edison company. It says:

"The interviews with Mr. Edison, which were recently published by the daily press, concerning his improved system of street car propulsion, seem to have given rise to a widespread impression that the new method is to entirely supersede the present trolley system.

"This is absolutely not so.

"Mr. Edison has devised the new system for roads of heavy traffic, in large cities where the expense of the original installation is warranted by the traffic, and where the trolley system will not be permitted. For instance, the new system would not be applicable, in a commercial sense, to long roads operating less than fifty cars simultaneously. It must therefore be understood that, outside of the large cities, the best system that can be advocated is the trolley.

"In order that a better understanding may be formed as to just what this new system for large cities is, we submit the following particulars, which have been furnished by Mr. Edison:

"The overhead system is entirely dispensed with.

"Cars, trucks, tracks and roadbed, such as are now in use, are retained, certain changes being made in the joints and cross-ties.

"The power, furnished by 1,000-volt generators, is distributed to reducing apparatus placed in boiler plate manholes at intervals varying in accordance with the number of cars required to be operated. At these various reducing points the current is transformed from 1,000 volts to a pressure of 20 volts, and put in direct communication with the tracks. This limit of 20 volts is fixed in order to prevent horses from being affected by the current. The economy of current is about the same as with the present system of trolley.

"The car motors being wound with uninsulated copper wires, and the pressure of current being so low, there is entire freedom from burning out of armatures, as water can be poured upon the armatures without any ill effect. The problem of producing a perfect rail joint, and the picking up of a heavy current from a mud-covered rail, has been solved in a practical manner. The experimental road at Mr. Edison's laboratory is a quarter of a mile long, with a six per cent. grade and very short curves. It is operated successfully when the rails are entirely buried in mud or in dry sand.

"Mr. Edison is arranging to have the system placed in practical operation on a heavy traffic road in some large city (probably New York) to demonstrate its practicability. This will be done during the coming year."

Considering the great number of roads now being operated by the Edison trolley system, and that this company is actively pushing this system, it is safe to predict that the trolley will enjoy its lead for years at least. Should Mr. Edison's most sanguine hopes for his new system be realized, it will, according to the above item, be limited to large cities, which form but a small fraction of the street railways of the country.

The electrical fraternity await with interest the details of this new scheme for rapid transit, as many seem to doubt its practicability and economy.

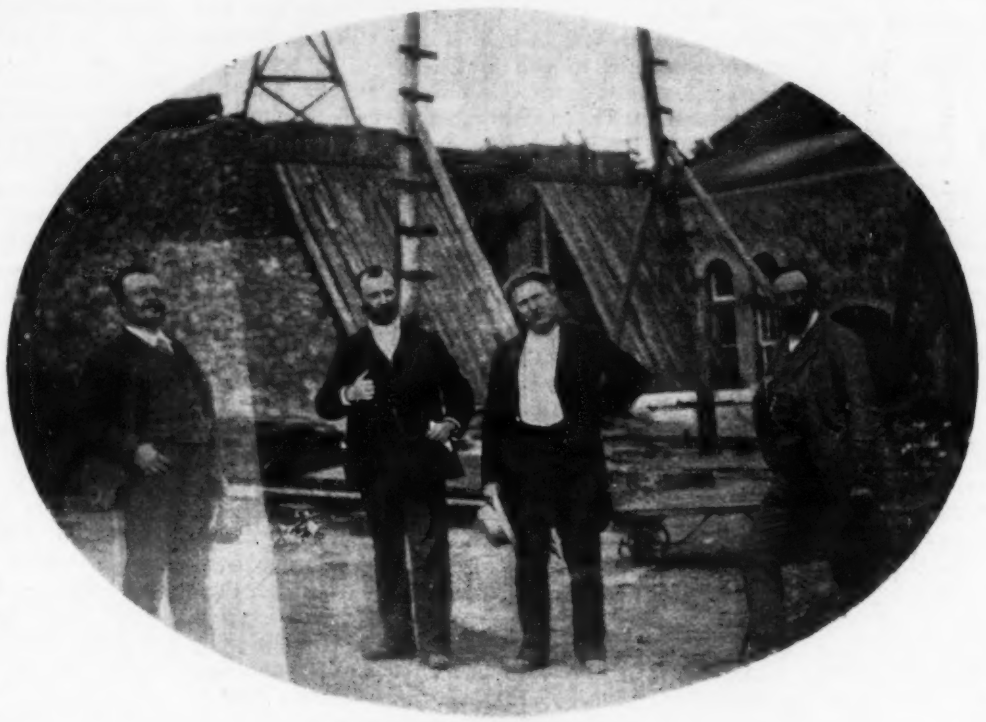
## Edison on Electric Mining and Other Topics.

As a sequence to the series of articles on "Electricity in Mining," which close with this issue of The Electrical World, a few words from Thos. A. Edison, indicating the interest he has taken in the subject of mining by electricity, will be of interest. To secure this The Electrical World's representative arranged for an interview with Mr. Edison one day last week.

Though exceedingly busy, Mr. Edison spoke fully and frankly, not only on the special topic of the interview, but on all live subjects. With quickness and precision the conversation ran from subject to subject, while his work, plans and inventions were spoken of with all the enthusiasm of youth. He spoke of new engines, power transmission plans and ore separating, as though he was just starting in life, and when the pleasant chat ended The Electrical World man felt that genius could never grow old.

The world has from time to time been made aware of Mr. Edison's magnetic ore separating apparatus. Recently renewed interest has been stimulated in his efforts in this direction by the erection at Ogden, N. J., of a large concentrating works. Here he found a typical New Jersey iron mine.

We give herewith a cut made from a photograph recently taken of Mr. Edison, as he stood with some visitors in front of the Ogden mine opening.



EDISON AT OGDEN, N. J.

Opened up probably over a hundred years ago, and quite extensively worked, this mine was abandoned because all the easily accessible high grade magnetite was removed and the low price of ore did not justify the following of the beds to still greater depths. The rock remaining is a mass 300 feet wide, three miles long and of a depth that is as yet unknown. Here Mr. Edison found a good field to demonstrate the value of his magnetic ore separating process. Electrically considered, the problem is simple. It consists of merely quarrying out the rock; transporting it to crushers, thence to rolls and screens, where it is crushed to pass through a sieve of 50 meshes to the lineal inch, thence to the magnetic separators, from which the separated magnetite is taken to be loaded on cars and the waste taken to the dump. Taking the element of finance into account, however, the problem assumes a very different aspect. The rock at this place contains 16 per cent. magnetite, whereas the percentage of ore in other rock generally worked is 64. To obtain from this Ogden mine a product that can be sold in competition with richer ores it is necessary to treat four tons of rock to obtain one ton of product.

"Oh, we are at work in earnest," said Mr. Edison in reply to a question. "We have some of the crushers actually in operation, and are turning out ore. It is quite a problem, to be sure, but when we get in working order we can easily solve it. I expect to put an annex to the present mill, and when it is finished we will pass 4,000 tons of rock through the mills in 20 hours, or 200 tons an hour. The quarrying will be done with electric drills. All the machinery, requiring hundreds of horse power, will be operated by motors. From one small power house, where we have installed triple expansion engines and direct-connected dynamos, the current will be sent to the various parts of the mill and mine, and thus we will be able to do even better than we at first figured.

"Why, just consider a moment. If I were to put in steam engines, shafting, pulleys and all the adjuncts of the ordinary mill power equipment, it would cost $300,000. With but two large high efficiency engines, dynamos and motors I can obtain the same result for a fraction of that. Then see the saving in operation. Now, this is not theory. Take the Schenectady works of the company. [He referred to the Edison General Electric Company. That is one of the largest industrial plants in the world, employing thousands of horse-power and thousands of men. Every piece of machinery and every inch of shafting in that establishment is operated by motors at an immense economy.] Look at the old practice. They had several small boiler and engine plants scattered about the different buildings. With the very best operation they realized only one horse-power from six pounds of coal. With the new engines and dynamos they get the same power from two pounds, and besides that confine the necessary boilers and engines to a small house. Just think of the opportunities the great New England milling districts offer to the electrical engineer. All along the rivers you find thousands and thousands of horse-power going to waste over falls and dams that could be utilized to run motors and operate their mills."

"You have noticed the recent efforts to use Niagara Falls for generating electricity," remarked the correspondent. "What do you think of that?"

"The American scheme seems feasible enough; but I suppose you refer to the Ferranti idea on the Canadian side." Learning that such was the case, Mr. Edison continued: "Suppose they do generate current over on the other side, what will they do with it? Send it to Buffalo and other places on our side of the fence? Never. They would tax every ampère so high that it would be prohibitive, and if that didn't work, we have a Congress."

The mention of Ferranti's name turned the conversation to the famous English electrician. "I consider him," said Mr. Edison, "the brightest electrician and engineer abroad: but the trouble with him, as with all other European electricians is, they do not seem to have a commercial governor to regulate them. Over there the business man and the scientist never pull together, whereas we are just the reverse. American inventors invent for what there is in it from a practical standpoint, and, consequently, we are away ahead of them in electricity. Science has of late taken on a different aspect from what it wore in times gone by. Its value is now dependent upon its service to the community, and I believe in that doctrine."

Edison's pet, the phonograph, was the next thing to which his mind was shunted. The Electrical World man gently referred to the rather backward seat that marvelous instrument had taken in the business world.

"Not at all strange," observed the inventor. "It took eight or nine years to demonstrate the value and beauty of the typewriter, that is, the writing machine," and he halted a moment to see if he had scored a joke. Being assured from the smile on his visitor's face that he had, he continued: "Now they are universal. It was the same way with the electric light and the electric motor. Humanity moves slowly, but when it strikes a pace, there is no stopping it.

"I firmly believe the day will come when business men will look upon the phonograph as an absolute necessity, as they already do in some of the largest offices in New York. It will some day be a factor in commercial life of the greatest value."

The conversation then drifted to the commercial aspect of the electrical industry, and this was being commented upon by the equally great business man and inventor when the little griffin who guards the entrance to the laboratory gently whispered to him that his father was down stairs.

Escorting the interviewer through the hallway and down the stairs with a quick, elastic step, Mr. Edison bade him good-by with a hearty hand shake. A moment later the elder Edison was greeting his famous boy "Tom," and the next instant the correspondent stood in the cold, rainy street painfully aware that during the pleasant talk with Edison he had been under a charm that can only be felt when the ordinary mortal is communing with a genius.

## American Institute of Electrical Engineers.

The following resolution, passed by the International Congress Committee and the Council of the American Institute of Electrical Engineers, is the outcome of the recent visit to New York City of Dr. Elisha Gray, of Chicago, Chairman of the Committee on the World's Electrical Congress. Dr. Gray, after several informal interviews with officers and members of the Institute, was invited to attend a meeting of the Congress Committee on Dec. 16, where a mutual exchange of views upon the subject was had and so far as is known the result is entirely satisfactory to all parties interested: "*Resolved*, That the American Institute of Electrical Engineers, having already taken action during the past three years, by correspondence and otherwise, toward the holding of an International Electrical Congress in connection with the Columbian World's Fair, hereby expresses its desire and intention to co-operate, by all means in its power, with the World's Congress Auxiliary of the World's Columbian Exposition, through its Electrical Congress Committee, in furthering the gathering of such a congress at Chicago in 1893, and in making it a successful and worthy representation of the best electrical science and practice in all parts of the world."

### Sketch of Ferranti and His Work.

Everybody in the electrical industry must have heard of Ferranti, and the gigantic Deptford station, which is and has been supplying London with electric current of a pressure of 10,000 volts for now nearly a year. For more than eight years the name of Ferranti has been prominently before the electrical fraternity, yet very little, if anything,

FIG. 1.—FERRANTI WINDING HIS FIRST DYNAMO

is known of the real work and personality of this bold and original engineer

Mr. Sebastian Ziani de Ferranti was born April 9, 1864, and is consequently now 26 years of age. He is an Englishman by birth and education. His ancestors include a line of royal personages who lived in Venice in the Twelfth century. Coming down to a more recent date, we find that his grandmother on one side was an American lady who came from Poughkeepsie, N. Y.

From boyhood Ferranti seems to have taken a great interest in inventions of various kinds. When only 16 years of age he built a complete electrical dynamo. This he did at Camden Square in London during the summer of 1880. While at work upon it, some member of his family made a sketch of him which we are able to reproduce in this article. This is perhaps the only likeness of Mr. Ferranti that has ever appeared in an electrical journal.

Shortly after his first attempt at dynamo building he constructed a model of his now famous disc armature dynamo. A full account of this interesting machine was given in THE ELECTRICAL WORLD of Dec. 1 and 8, 1888. The young inventor worked with great persistency on his dynamo, and very soon came under the patronage of Sir William Thomson, the great English electrician. This resulted in the formation, some time in 1881, of the firm of Ferranti, Thomson & Ince. Mr. Ince, it might be added, is now Ferranti's father-in-law, and has followed the young man's fortunes from the very start. These early experiments and efforts were quite extensively noted in the London papers at the time.

Ferranti afterward spent some time with the well known house of Siemens Brothers, leaving them because he felt there was not sufficient opportunity given him for the development of his ideas. Returning to London he invented, in 1883, what he then called the "Rabbit" dynamo, shown in Fig. 2. This, it will be observed, is identical with the well known Eickemeyer dynamo in principle, and is in fact the same type of machine.

Mr. Ferranti's efforts gathered strength as time went on. With the tenacity of a genius, he kept at work experimenting with and building dynamos, as well as perfecting a system of distribution. The result was that without much noise or pretensions the world renowned Grosvenor Gallery station took form. Some time in 1884 Sir Coutts Lindsay, a great friend and admirer of young Ferranti, made up his mind to light this gallery by electricity, using the young inventor's alternating system. He mentioned the fact to a neighbor and that gentleman at once said: "Put down twice the necessary machinery and produce twice the current you require and let me have what you can spare." Very soon other neighbors joined in the request for electric light, and Sir Coutts Lindsay began a very modest installation; but long before it could be completed the demand became larger and larger. At length this enterprising nobleman associated a few gentlemen with himself, among them the Earl of Crawford and Lord Wantage, and a small private company was formed with the title of Sir Coutts Lindsay & Co., Limited, but owing to its origin was familiarly known as the Grosvenor Gallery Company.

By degrees the city of London grew to appreciate the advantages of the electric light, and very soon this modest station was carrying a load of 40,000 incandescent lamps. All the machinery was especially designed by Ferranti, and the entire equipment installed after his ideas. All this had been going on very quietly, and it was not until the autumn of 1888 that the scientific and industrial worlds were startled by the announcement that the company was to build at Deptford a giant station to supply the city of London with 5,000,000 incandescent lamps at a cheaper rate than gas. The original Grosvenor Gallery Company had been merged into the London Electrical Supply Corporation, organized in August, 1887, with a capital of $5,000,000.

The electrical fraternity are familiar with the details of the Deptford station, with its 10,000-h. p. engines and dynamos of unprecedented proportions, supplying light to London, a distance of eight miles, at a pressure of 10,000 volts. The announcement of these plans caused no little excitement in London, and led to many peculiar utterances in the daily papers. A specimen paragraph from the *Financial News* of Oct. 24, 1888, will show to what extent Mr. Ferranti's plans were accepted by the London public. "The designers of the building seem to have revelled in engineering devices and labor saving ingenuities. Vulcan would be a baby beside them, and Hades a country smithy in comparison with theirs. With their 10,000-h. p. engines and 40-foot dynamos, they will brew the electric fluid like beer and distribute it like gas—more easily and cheaply than gas in fact. A copper pipe less than half an inch in diameter, which can be run along a wall, will carry as much lighting power as the largest gasometer in London. It need not be put underground unless convenient. At Deptford only half a mile of underground tube will be needed to connect the works with the South Eastern station. After that it is simply to be carried along the railways into London. Hundreds of thousands of pounds which the gas companies had to spend in pipe laying will thus be saved."

While this language may sound rather startling, it did not, however, misstate the facts. The plans of the station included units of the capacity given, and its erection went steadily on. Current was to be driven under a pressure of 10,000 volts to the city of London. Here it was first transformed to 2,500 volts, and then by another converter to the ordinary voltage needed at the lamps. From the sub-cellar

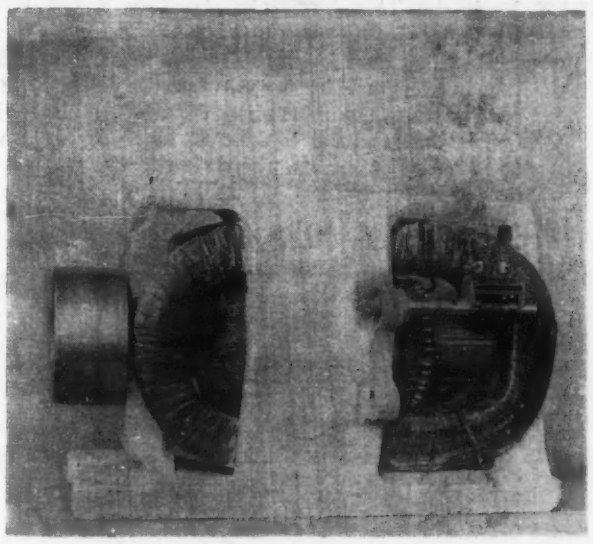


FIG. 2.—ONE OF THE EARLIEST OF FERRANTI'S DIRECT CURRENT MACHINES.

to the pinnacle of the roof, this great station, with an ultimate capacity of millions of lights, was the creation of young Ferranti. He even designed a new system of steam-piping which it would seem now is going to revolutionize steam-piping practice.

To use the words of the London *Electrician*, "the members of the press who were invited to visit the Deptford station came away with a vivid impression, not only of the magnitude of the undertaking, but also of the sheer audacity—there is no other word for it—of its promoters."

Thus, at the age of 24, Mr. Ferranti saw his ideas assuming material form in the largest central station in the world, backed up by a corporation of $5,000,000 capital, that including some of England's most prominent citizens.

The electrical and engineering problems which the Deptford station has undertaken to solve are not the subject of this article. The impression seems to have gained ground that it is not a success. A prominent American engineer who has only recently returned from England, where he spent a great deal of time in examining the station, states that Ferranti has failed in nothing; business with the London Electrical Supply may just now be slow, but he firmly believes that not only will Ferranti's methods be ultimately a success in London, but they will be copied all over the world. But whatever is the destiny of the great strides taken by Ferranti, they will stand conspicuous as an imperishable monument to the indefatigable energy and daring originality of this wonderful engineer.

The fire which destroyed the Grosvenor Gallery station was a serious blow to the young inventor. The carelessness of a lineman, or rather through his losing his nerve and failing to break the circuit by simply throwing a switch, caused a conflagration that in half an hour destroyed thousands of dollars' worth of apparatus that could not be duplicated at any cost, for the reason that it had all been specially designed for the purpose. For a time the system was completely disabled. Not disheartened, however, Mr. Ferranti and his company braved the tide of ill luck which set in against them, and nearly all the customers lost by reason of the fire have now been connected to the station again.

In September, 1889, when Mr. Edison was in England, he paid a visit to the Deptford station. A very interesting account visit of the of the great constant current advocate to the high pressure station is found in the London papers of the period. The *Daily News* of Sept. 26, quotes Mr. Edison as saying, with reference to the station then in course of construction: "Mr. Edison spoke of the risks of an enormous pressure through a narrow wire. But I must carefully guard the reader against supposing that Edison thinks the London Company's method 'won't do.' It is a question of how to obviate the risks, the existence of which Mr Ferranti himself admits. Mr. Edison, when summing up his impressions, exclaimed in his hearty way, 'oh it will go.'"

Mr. Edison bewildered the British scribe by discussing the various features of electrical distribution, calling attention among others to the practice in America of using several dynamos upon which the lighting of a town can depend rather than on one station as in the Deptford station.

A gentleman of the party was remarking that if "once" a breakdown happened, public confidence in the new light would vanish. "Twice," said Edison; "the first time the public will excuse you, they will make allowance for inexperience; but if you do it a second time, you are done for."

Edison's visit to Deptford brought out a romantic incident in connection with Mr. Ferranti, whom some one has dubbed the Edison of England. "Mr. Ferranti," says the *Pall Mall Gazette*, "a tall, slim young man, with dark Italian eyes—told me that it was the study of Edison's work in his boyhood that determined him to follow in Edison's footsteps."

In appearance Mr. Ferranti looks older than he is. He is about medium height, dark complexioned, slender in build, with a thin, keen and most expressive face. He has the dark, fathomless eyes of the Italian, but his keen, smooth face shows the practical English side of his nature. It is stated that as early as 12 years of age he was engaged in making models of locomotives, and even at that age developed ideas that have since been adopted, that is, larger wheels and greater driving power.

It has been hinted that Mr. Ferranti is thinking of extending his operations to this country and taking up his residence here. If this is so it will be a great gain to the electrical forces of our continent. Ferranti heads the list as one of the boldest of engineers and long distance electrical transmission experts; and his achievements in this line have made his name great among the inventors and promoters of the world.

Here in the United States he would have larger opportunities for developing long distance transmission of power. Niagara Falls and similar water powers open up an inviting field for a man like him to cultivate and conquer.

Should the practical nature of long distance transmission

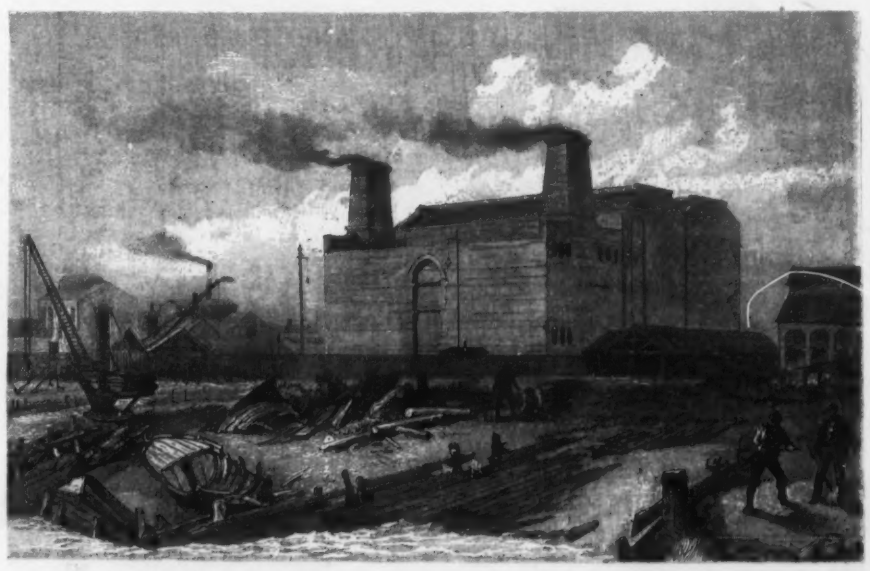


FIG. 3.—EXTERIOR VIEW OF THE DEPTFORD WORKS.

be demonstrated, say from Niagara Falls to Buffalo, a vast field for profitable development of water powers will be opened to the electricians of the country. Ferranti has full faith in his ability to utilize Niagara Falls, as he has successfully demonstrated that currents of 10,000 volts can be handled and utilized for useful work. It is to be hoped that he may some day find a home among us.

## Electric Lighting in New York City.

Electricity is the pervading spirit of the last quarter of this Nineteenth century, and New York is more nearly its especial shrine than any other city on the face of our electrified planet, for not only is the electric light more widely distributed through this metropolis than through any other, but New York was the birthplace of incandescent lighting, and the first great field for the electric arc.

Glancing back a little over a decade even the New York boy can remember the expressions of wonderment that greeted the erection of the great masts in Madison and Union squares crowned with a circle of arc lamps. He may dimly remember, too, the wonderful reports in the newspapers of the final success of the attempt to subdivide the electric light, and the tales of the queer little bamboo filaments shut up in exhausted glass globes that were to revolutionize the illumination of the world. Then, too, he can recall when his elders talked of that famous application of the subdivided light by Edison in the New York *Herald* office, and the installation in the United Bank Building, devised by Sawyer and Man, Edison's earliest competitors.

Standing in the centre of the theatre district of a winter evening, nothing but the electric light is evident, and that whole region of Broadway is aglow with brilliant arcs and glowing incandescents. Our artist in Fig. 1 has depicted the scene with almost the fidelity of a photograph, and with more realism than any photograph taken at night could possibly afford. No less striking is the electric light on lower Broadway at the hour when the half million New Yorkers that do business in the terminal end of the island are hurrying to their respective homes. Our sketch on page 6 (Fig. 5), will give some idea of the appearance of City Hall Park when the illumination is in full blast. It is a striking scene—the open space with the tall city buildings rising in it blazing with arc lights casting sharp shadows of the pedestrians in grotesque forms upon the pavements. Beyond towers a part of Newspaper Row with its huge buildings consecrated to the great metropolitan dailies the *Times* and *Tribune*. In the former The Electrical World has its offices. These great structures rising against the sky and visible from far across either river are by six in the evening glowing in every window with the incandescent lamps within. And not until the thousand offices have disgorged their occupants does the illumination begin to cease. Even then in the upper stories of each building the windows shine out into the darkness until far into the morning hours, when the papers have at last gone to press, the night editor departed, and the last weary printer has enveloped himself in his overcoat and fled to gain his hours of misplaced sleep, and even then far uptown the light of later days is still in its glory.

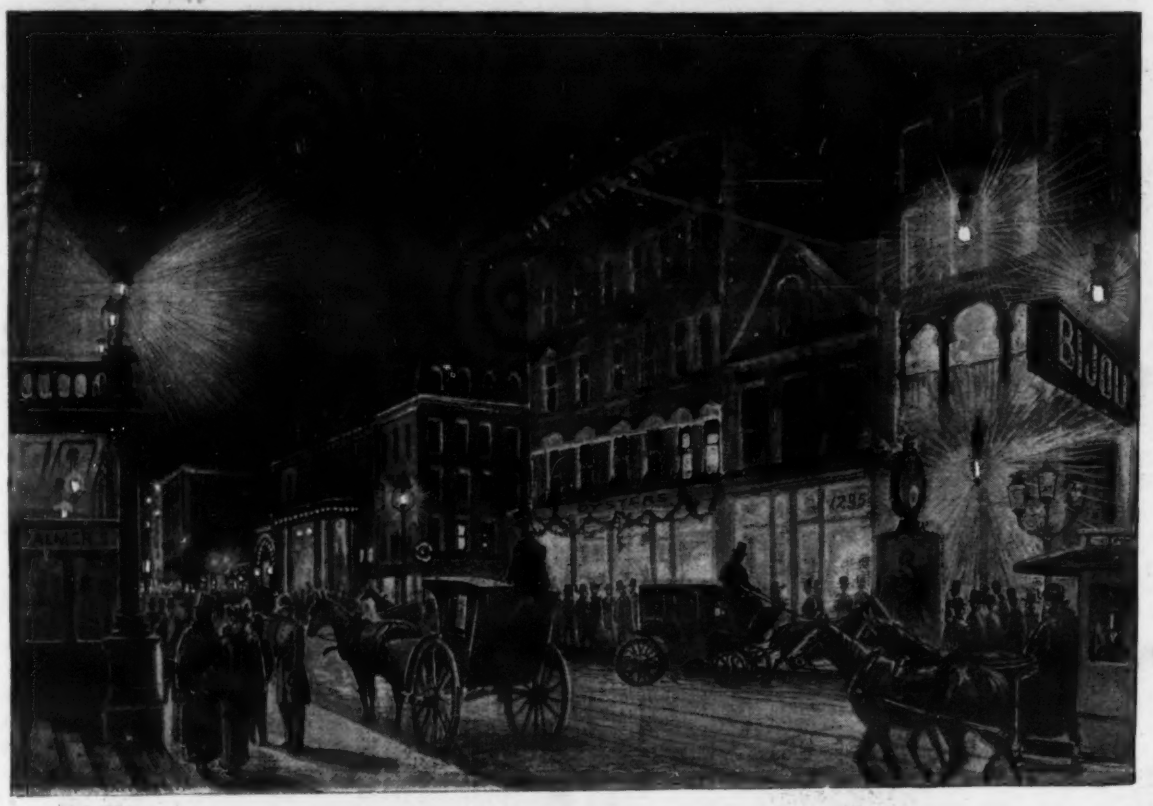



FIG. 1.—A NIGHT VIEW IN THE THEATRE DISTRICT ON UPPER BROADWAY.

Standing in Central Park and looking across the intervening shrubbery at Fifty-ninth street, almost deserted in the evening, one sees rank on rank of towering apartment houses, apparently illuminated from basement to roof in honor of some great popular demonstration, which, however, fails to materialize on being sought for. The artist has chosen a point of view that brings into brilliant prominence the Navarro flats, and the scene is surely one of striking beauty.

Even more striking, perhaps, than any of these views is the vague sky glow that announces the existence of the metropolis from a dozen miles away, and all this is the product of barely more than 10 years of progress in electric lighting. The growth has been marvelously swift, and yet so gradual that it is hard for the native of the city to realize how enormous it has been, and that the little glow lamp despised of gas companies has taken Manhattan Island for its own. And yet one must not suppose that the consumption of gas has materially decreased, for wherever the electric lamp comes human rivalry insists on burning enough of something to get up an approximately equal illumination in its neighborhood.

Yet, strange to say, the arc lamp—pioneer in the field though it was—is less numerous than of old, in so far, at least, as the streets are concerned. Five years ago Fifth avenue was lighted from end to end with electricity, but has now resumed illumination by gas, except in the short section from Twenty-third street to Washington square. This may seem strange at first sight, but to one who is familiar with the history of the electric light in New York City the reason is apparent. At first overhead wires were freely strung and lamps connected, until every circuit was loaded to its utmost capacity; then came, however, the evil days when the city authorities insisted that the wires must go underground, partly in response to public sentiment against the danger of overhead lines, partly owing to the pressure brought by rival companies, and also, perhaps, in a great measure to that indefinable something known to the ward politician as "de pull." With all fairness let it be said that although the arc lighting interests contributed in part to their own destruction, they have been treated in a somewhat summary and high-handed manner by the powers that be.

Five years ago New York electricians were wont to insist, with violent and repeated asseverations, that arc wires could not be put underground, that the insulation would not last, that proper subways could not be built, that decent service was impossible to be given under such

FIG. 2.—BLOCK OF ELECTRICALLY LIGHTED APARTMENT HOUSES AT THE END OF CENTRAL PARK.

conditions, and that in fact the whole idea was possible only in the imaginations of the city officials ; and this in spite of the fact that elsewhere in other cities and other lands arc wires were then running successfully underground. A prolonged legal wrangle ensued, vicious in its progress and disastrous in its results ; and when finally two or three years ago the Mayor's little hatchet was laid at the foot of the electric light poles and wielded with more energy than discretion, it was suddenly discovered that a conduit service could be readily established, and the lament now is that conduits are not furnished rapidly enough, and such indeed is the case, for from one or another of the causes suggested the company that unfortunately secured the

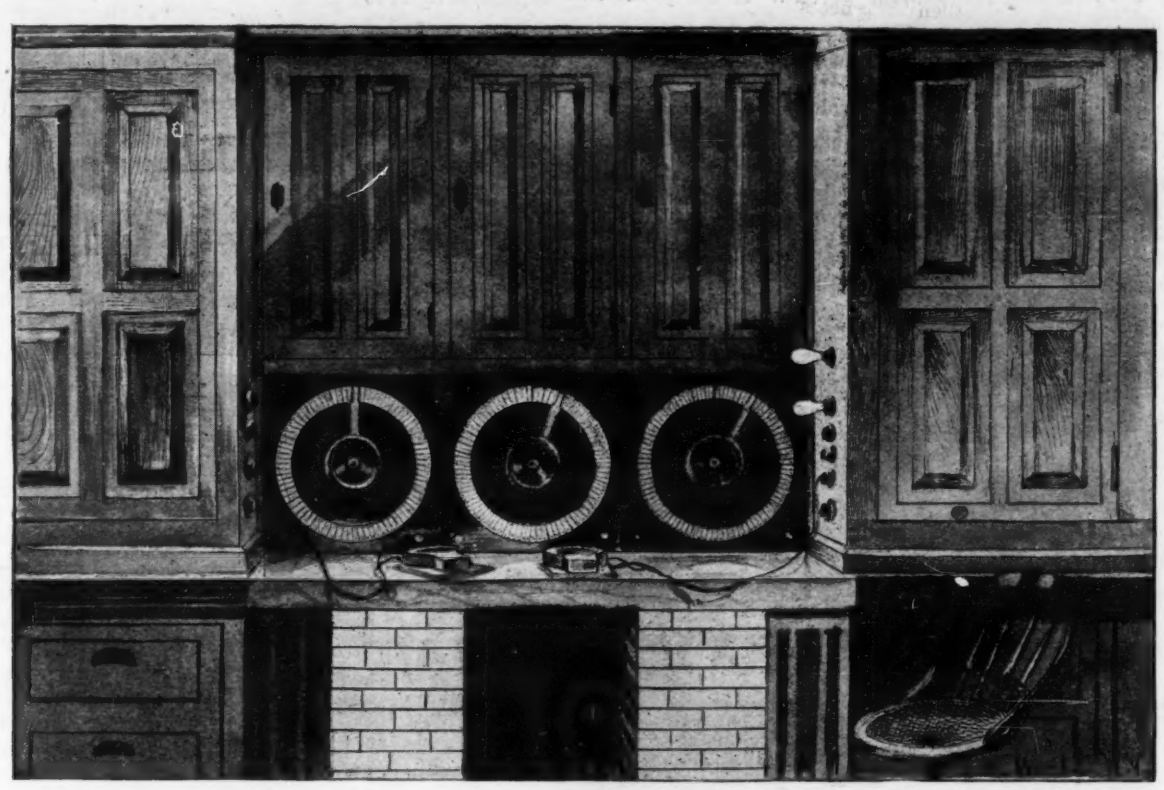


FIG. 3.—CONTROLLING MECHANISM OF THE EDISON NETWORK OF LIGHTING MAINS.

monopoly of conduit building has gone ahead with the exasperating slowness of the snail. The result has been unfortunate, and to-day there are probably only about 3,000 arc lamps doing public lighting, with at least this number in commercial installations ; part of them, however, running from private plants. The load is divided over seven central stations, which are so located as easily to cover the entire area of the city. Were ample conduit facilities now at hand it is certain that not only would the arc lamp regain its old prestige but would begin a new era of unexampled prosperity. In some localities even now—notably the Bowery and Eighth avenue—public and private arc lamps are sufficiently frequent to show what might be done under better auspices. Broadway, in fact, through its entire length is so lighted.

Meanwhile, however, the incandescent light has had a steady period of prosperity. The Edison company was peculiarly fortunate in having the permission to lay its excellent system of underground tubes independent of the subways; a permission granted in the early days, before the bitter wrangling between the city authorities and the electric lighting companies had assumed its present wretched prominence.

Before the close of 1886 the capacity of the Pearl street Edison station, which was then about 50,000 lamps connected, was exhausted and the extension of the system into the uptown districts was already begun. At the present time there are two great uptown stations in addition, one on Twenty-sixth street and still another on Thirty-ninth street. Each of these has an ultimate capacity of 50,000 lamps, although, of course, they are not all connected.

The entire district handled by the Edison company now comprises a long and moderately wide strip beginning at the Battery and extending, roughly speaking, half a mile on either side of Broadway, up to Fifty-ninth street. Perhaps a fair estimate for the entire number of lamps connected would be 118,000, though, of course, nothing like that number is nightly used, for not only are many buildings wired for a number of lights greatly in excess of those immediately required—the result, doubtless, of the system of metering electricity that is now in general use—but the centre of maximum illumination shifts during the day's run, so that at no one time are all the lights burned daily in simultaneous use. Down town the mains are fully loaded only during the business hours of a winter evening, although the work of the stations is continuous throughout the day and considerable load is carried far into the evening, not only in various buildings regularly connected during the day, but in some others which until six o'clock are lighted from independent installations and only connected to the central station mains during the evening hours. Until within a very few months in fact the three great Edison stations were operated independently of each other, the Pearl street station handling the downtown district, the Twenty-sixth street station the great theatre region, and the Thirty-ninth street station the houses and shops uptown, including a large part of Fifth avenue. Now, however, these three centres of distribution are all connected for the purpose not only of securing the system against suspension of operations from accidents at a single point but to enable the load to be so divided that the machines in use can be loaded to their fullest capacity. Engines and dynamos give the best results when worked to their full output, and when the lighting which would ordinarily be handled by a single circuit becomes small in amount it is most desirable to cut off the direct supply and furnish current from other machines, perhaps in other stations, that thereby may be fully loaded and worked at the point of highest efficiency. So at the present time the mains are cross-connected and, if necessary—in case of a somewhat improbable series of accidents—fair results could be secured by handling the entire lighting district from one or two of the three stations. It would not be a particularly economical method of running, but would tide over what otherwise would be a break in the continuity of service, than which nothing more disastrous can befall an electric lighting company. This system of "network," covering the entire district to be illuminated has not been extensively used in this country until now, although in Europe there are excellent examples of such an arrangement. The "network" requires skillful handling and careful calculation of the wiring in order to produce the best results. As it is now, however, the entire Edison system is operated from the Twenty-sixth street station, where centre all the "pressure wires" that tell whether or no distant lamps are burning up to their full brilliancy.

From a single spot the entire system is controlled, and a glance at the apparatus will tell if any part of it is not in proper working order. This central spot is the heart of the Edison network whence somewhat indirectly, it is true, ramify the arteries and veins of electric current. It is shown in Fig. 3. It is a beautifully devised system and has proved very successful.

Its operation is somewhat as follows: The downtown station at Pearl street is operated continuously 24 hours in the day. The heaviest load comes between four and six in the winter evenings ; after the latter hour most of the offices are closed, although many of the large isolated plants operated on the Edison system shut down their machines and receive current from the mains for lighting required after regular business hours. The central station at Twenty-sixth street is also operated continuously, but the third, the Thirty-ninth street station, runs only between one o'clock in the evening and one o'clock at night. During the remainder of the 24 hours its slight remaining load is taken from the Twenty-sixth street station by means of auxiliary feeders connected to its proper network. The downtown district is permanently connected to both the uptown stations as well as to the temporary station at Elm and Pearl streets. This latter is now nearing completion, and when finished will be the main station of the entire system, and is intended for a total capacity of 150,000 incandescent lamps. At present, however, it is comparatively small, only a substation, in fact, operated a portion of the day.

The Edison system constitutes by no means the whole of the incandescent work of New York. Beginning work, as it did, very early in the development of the art it probably has at present about half of the incandescent lighting of the metropolis conducted from central stations. Aside from it the largest system is that of the United Electric Light and Power Company, also an old organization, with wires covering a large portion of the lower part of the city.

This employs for its incandescent service the Westinghouse alternators distributing current on the well known transformer system. It is hard to give to one unfamiliar with it an adequate idea of the mechanism of this really extraordinary means of distributing current. In a general way it consists of a series of small line wires carrying a relatively small amount of current but at a very high tension. These wires, whenever it is necessary, connect to converters which transmute a portion of the main current by electro-magnetic induction into an independent current totally disconnected from the mains, considerable in amount but of very low voltage—only about half that employed in the Edison system. This arrangement insures both economy and safety.

The main alternating station doing incandescent lighting is on Twenty-ninth street near the East River, and the wires from it are carried in underground conduits, now, fortunately, tolerably numerous over an area covering a large part of the space that lies between Fifty-ninth street and the Battery. The effective radius over which light can be distributed on the alternating current system is considerably greater than that practicable through the Edison low tension mains, and so the lights are connected in strangely ramifying districts far down the cross streets and united into a central strip along Broadway, interlacing with the Edison "network" and stretching out irregularly beyond it on either side.

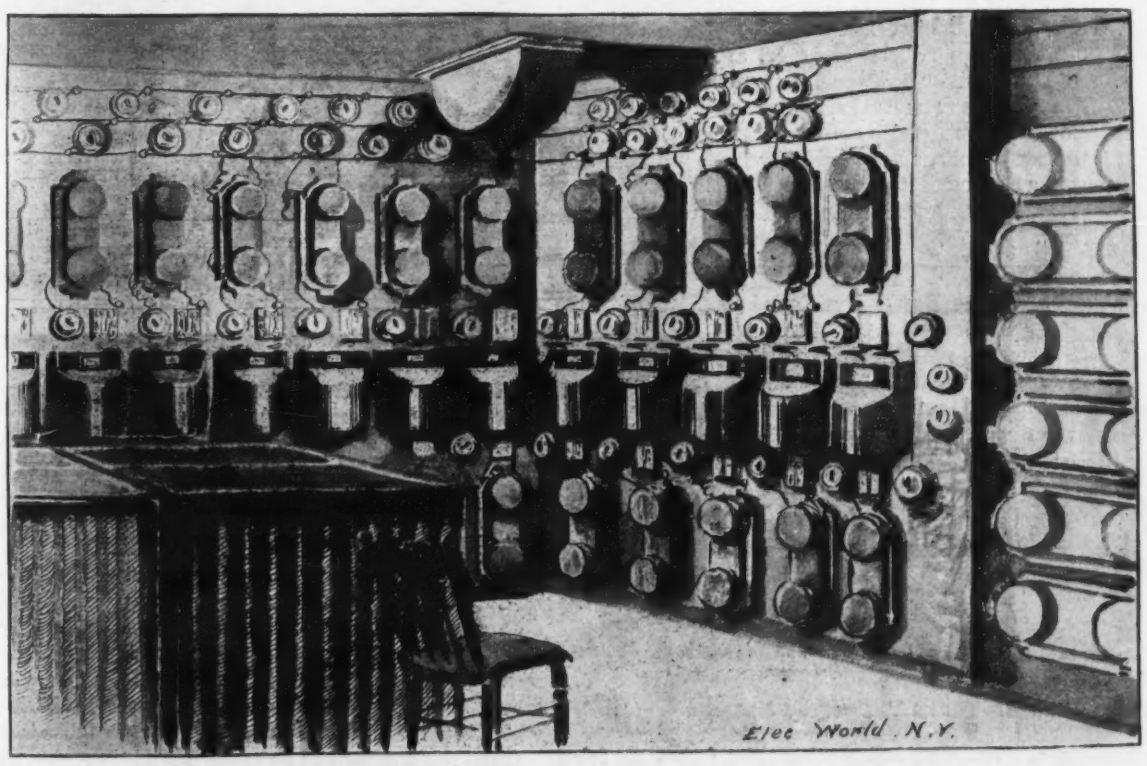



FIG. 4.—BANK OF TRANSFORMERS IN THE CASINO, NEW YORK CITY.

There are some peculiar features about this system of distribution that are worthy of particular attention. It is a fact seldom appreciated by electricians—especially those familiar with direct currents only—that transformers can be worked in parallel with each other, that is, that when a system requires the use of a large number of lights a considerable number of small transformers can be worked in harmony through a single set of mains. Of course, one big transformer might be installed in their place, but transformers, like dynamos, work best when fully loaded, and during periods when but few lamps are connected it is possible if several transformers are used to disconnect part of them and allow the

remainder to work at full load. In spite of the prevailing belief to the contrary, transformers are in this city habitually worked in banks connected in parallel. In fact, of the 70,000 lights operated by the single company mentioned in this city, more than half are supplied from "banked" transformers. To give an idea of what such an installation really is Fig. 4 shows a sketch of the largest transformer bank in New York, of capacity less, to be sure, than some similar installations that are in use in England and on the continent, but including a multiplicity of transformers that is probably unequaled. It furnishes the lights for the Casino at Thirty-ninth street and Broadway, and consists of 56 40-light transformers banked in parallel and feeding a single set of mains from which light is distributed all over the building. A similar bank of a somewhat curious character is installed in the New York Post Office. In this case, two transformers are placed in series with each other and then a number of these batteries are united in parallel. The building was originally wired for lamps of much higher voltage than is ordinarily supplied by transformers, so that it became necessary to put two in series in order to correspond with the wiring already in the building.

There is also in the Twenty-ninth street station a very ingenious and perfect switchboard arranged so that any dynamo in the entire installation can be connected to any set of mains or feeders, thus resulting in removing any probability of discontinuity of service by reason of a failure of any of the machines in the central station.

But this is not all of the incandescent lighting. Two other stations, that of the Mt. Morris company, far above Central Park, and that of the East River company, also carry heavy loads of incandescent lights covering districts not yet effectively reached by the other systems. Both of these are also alternating current stations and their circuits stretch as far as the existing subways will permit their primary mains to be carried. Neither of these stations has the capacity of the stations previously mentioned, but between them perhaps 50 or 60 thousand lights are connected.

Aside from all this a large majority of the newer apartment houses, office buildings and factories are provided with "isolated" incandescent systems of their own. Of their number and capacity it is possible to form only a rough estimate, but all told there are probably now used in New York City not less than 300,000 16-c. p. incandescent lamps.

The only other city in the world in which incandescent lighting is developed to a point which is fairly comparable with these figures is London, where, at the beginning of the current year, the number of incandescents was estimated at 264,000, a considerable portion of these, however, are 8-c. p. lamps, to which basis the above estimate is reduced. By a similar process of computation New York would have to be credited with about half a million incandescents, as the lamps in this city are almost without exception 16-c. p.

So rapid is the development of incandescent lighting that it is hard to follow the progress that is being made, or to estimate even approximately the exact number of lamps installed. The above figures, however, are not far from the truth and no better evidence is needed to show that New York City to-day stands alone in the extent to which the electric light is regularly employed within its limits. Great is the metropolis, but greater yet is the progressive spirit that in a single decade has made possible a development that is almost unique even in the swift rush of electrical history.

## Measurement of the Power Developed by Alternating Currents in Any Circuit.*

BY CARL HERING.

Having now illustrated why it is that in measuring alternating current powers we cannot multiply the current by

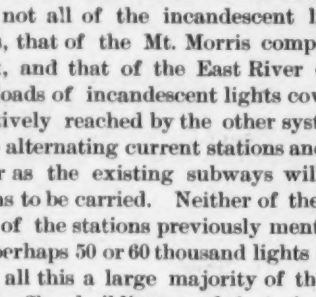



Fig. 4.—Three Voltmeter Method.

the voltage, without considering other things also, the following abstract of the above-mentioned articles may, perhaps, be better appreciated by those to whom these subjects were not clear. The various methods given below were suggested by Messrs. Ayrton, Sumpner, Swinburne and Fleming. The proofs of the formulæ, together with further information, may be found in the original articles.

Let it be required to measure the amount of power developed in any circuit $a\ b$, Fig. 4, no matter whether it be inductive or not, place in series with it a resistance $c\ d$ whose resistance is $r$ ohms. This resistance $r$ must, however, be a simple resistance, and must not be inductive, that is, it must be a non-inductive resistance, such, for instance, as a liquid resistance or an arrangement of wires which will have no inductive effects, or in general any circuit in which no magnetism is developed. It must therefore contain no solenoids or magnets of any description, and for accurate work not even an ampère meter. With three voltmeters measure the voltage at the terminals of each of these two portions of the circuit, and also at the terminals of the two in series, as shown in the figure; the latter voltage is not necessarily equal to the sum of the other two, as it would be for continuous currents. Let these three voltages be represented by $V_1$, $V_2$ and $V_3$, as shown in the figure. The power which is consumed in the circuit $a\ b$ may then be calculated directly in watts from these three voltages and from the resistance $r$ (in ohms), as follows: square the three voltages, add those of $V_1^2$ and $V_2^2$, and subtract their sum from $V_3^2$; this, divided by twice the resistance of $r$ in ohms, will give the true power consumed in the circuit $a\ b$ in watts. This may be expressed by the following formula, in which $W$ is the power in watts:

$$W = \frac{V_3^2 - V_1^2 - V_2^2}{2\,r}.$$

As an illustration, suppose $V_1 = 50$, $V_2 = 52$, $V_3 = 100$ volts and $r = 5$ ohms; the power will then be $10000 - (2500 + 2704) = 4796 \div 2 \times 5 = 479.6$ watts. If the voltmeter has a resistance appreciably small compared with five ohms, then, instead of five ohms, use the joint resistance of the two, which will be slightly less than five; also subtract the watts consumed by the voltmeter from the final result.

The best conditions for the test are obtained when the

Fig. 5.—Lighting of Newspaper Row Overlooking City Hall Park.

voltage at the terminals of the resistance of $r$ is about the same as that at the terminals of $a\ b$.

The authors state that, with an error of one per cent. in each of the measurements of the three voltages, there would be a probable error of from four to five per cent. in the measurement of the power.

Instead of using three voltmeters, one may be used and connected to the respective parts of the circuit in rapid succession. The voltmeters had better be electrostatic (that is, electrometers), as they ought not to take an appreciable current, otherwise there will be errors introduced. A Cardew voltmeter, for instance, is said to take from 20 to 30 watts at high readings, and would, therefore, introduce large errors in measuring small powers. If the voltmeters are not electrostatic, that is, if they take an appreciable current, it will be more accurate to take the combined resistance of $r$ and the voltmeter in multiple arc, instead of the resistance of $r$ alone; also, to subtract the amount of power consumed in the voltmeter $V$ from that which is obtained by the calculation for the circuit $a\ b$.

If the resistance $r$ can be made just half an ohm the calculation will be simplified, as the power in watts will then be found by squaring the three voltages and subtracting the sum of the two smaller ones, namely $V_1^2$ and $V_2^2$ from the larger one, $V_3^2$; that is, $W = V_3^2 - (V_1^2 + V_2^2)$, in which $W$ is the true power in watts.

This method is entirely independent of any sine curve hypothesis, and is true whether the circuit $a\ b$, in which the power is to be measured, is inductive or not.

Voltmeters are usually graduated to measure the square root of a mean square of an alternating voltage, although they really measure the mean square, and not the square root of the mean square. In this method, it would be better that they should be graduated in mean squares, and not in the square roots of the mean squares, thereby avoiding the necessity of squaring the readings. In that case the probable percentage of error in the measurement of the power is stated to be from 2 to 2¼ times the error in the measurement of each of the voltages.

### Approximate Calculation.

The following approximate calculation is given by the authors, Messrs. Ayrton and Sumpner. If, as is usually the case, the scale is graduated in square roots, the trouble of taking the squares may be saved when $V_1$ does not differ much from $V_3$ by proceeding as follows:

Calculate an auxiliary quantity $a$ as follows:

$$a = 200\,\frac{V_1 - V_2 - V_3}{V_1},$$

then $a$ will represent approximately the amount in per cent. that the true power is less than the apparent power. The apparent power (that is the power that would be absorbed if there were no lag between the voltage and the current) is equal to

$$\frac{V_1\ V_2}{r}$$

or if $A$ is the current (that is the square root of the mean square of the current) this power will be equal to $V_1\ A$, the same as for a continuous current. Diminishing this by $a$

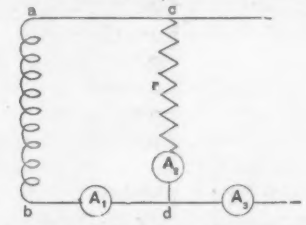



Fig. 5.—Three Ampere Meter Method.

per cent will then give the true power approximately; the conditions being that $V_1$ and $V_2$ do not differ greatly from each other, and that their sum does not differ much from $V_3$.

To illustrate this, let $V_1 = 50$, $V_2 = 52$, and $V_3 = 100$, then from the above formula $a$ will be equal to 8 per cent. The apparent power will be, for $r = 5$.

$$\frac{V_1\ V}{r} = 520 \text{ watts};$$

diminishing this by 8 per cent. gives about 478.5 watts (the correct value is 479.6 watts).

### Modifications.

If the resistance $b\ c$ is not known, or if there is any fear that it may be changed by the passage of the current, then an ampère meter (an alternating current ampère meter, of course) can be inserted in the main circuit. Let $A$ be the reading of this ampère meter, which represents the square root of the mean square of the current, then as $A$ is equal to $\frac{V_2}{r}$ we can substitute for $r$ its value $r = \frac{V_2}{A}$, and the formula will then be

$$W = \frac{A}{2\,V_2}\,(V_3^2 - V_1^2 - V_2^2).$$

In this case the non-inductive resistance $r$ may be made up of incandescent lamps, for instance, since there is no objection to the resistance varying with different strengths of the current.

In order to avoid the objection to introducing an ampère meter into the circuit on account of its inductive effect, the present writer suggests to place the ampère meter in the main circuit outside of the points between which the voltages are measured. In that case the voltmeters must, however, take only inappreciably small currents.

### Application to Measuring the Output of an Alternating Current Dynamo.

In order to avoid having to use, as is usual, a large non-inductive resistance to absorb the whole power of an alternating current dynamo, the same authors give the following application of their method:

Use a non-inductive resistance for only a small portion of the external circuit and arrange it in the same way as

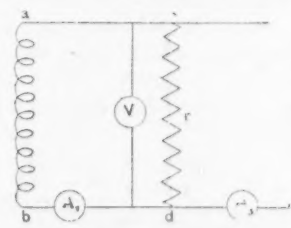



Fig. 6.—Combined Voltmeter and Amperemeter Method.

shown above in Fig. 4; then the total power in the whole of the circuit (the inductive as well as the non-inductive part) will be, in watts:

$$W = \frac{V_3^2 - V_1^2 + V_2^2}{2r}$$

or in other words, square the voltages, add $V_3^2$ and $V_2^2$, and subtract $V_1^2$, then divide by $2r$, the $r$ being, as before, the non-inductive resistance in ohms. To illustrate this by an example, we use the same numbers as in the example above, then

$$W = \frac{10{,}000 - 2{,}500 + 2{,}704}{10} = 1{,}020.4 \text{ watts}.$$

It will be seen that this is the sum of 479.6 watts, which was found to be the power in the inductive circuit, and 540.8 watts (equal to the $C^2\ r$ for the non-inductive resistance).

They anticipate that even if only a small portion of the external circuit is non-inductive, this method will give more accurate results than is often obtained by assuming

*Continued from The Electrical World of Dec. 26, 1891.

that a so-called non-inductive circuit is really non-inductive, and therefore that the apparent power is the true power.

FLEMING'S MODIFICATION.

This voltmeter method has the objection that if, as is often the case, it is desired to measure the power which is being absorbed in a portion of the external circuit of a system, the dynámo would have to be forced to generate a much higher voltage than the normal, on account of the introduction of the resistance $r$, assuming that the measurement is to be made without interfering with the voltage in the rest of the external circuit. This would often be awkward, and in many cases, in fact, out of the question. In order to overcome this objection Dr. Fleming has suggested the following modification of this method, which will be applicable in such cases, and will enable transformer tests to be made on working primary circuits without interfering with the voltage of the alternator.

Instead of placing the non-inductive resistance $r$ in series with the external circuit $a\ b$, place it in multiple arc with the same; and instead of using voltmeters use ampère meters $A_1$, $A_2$, $A_3$, as shown in Fig. 5. Messrs. Ayrton and Sumpner have pointed out that for every problem involving alternate *voltages* in *series*, there was an analogous problem involving alternate *currents* in *parallel*. It will be seen by comparing Figs. 5 and 4 that the former is quite analogous to the latter. In this case the formula will be

$$W = \tfrac{1}{2}r\,(A_3^2 - A'^2_2 - A_2^2),$$

which is seen to be quite analagous to the other, except that $r$ is used as a multiplier instead of a divisor. This method is inferior to the other, in so far as it requires the use of three ampère meters, which must be accurately calibrated; it is not possible in this case, as in the other, to switch the instruments successively into the three places; in using the voltmeter method, it is an easy matter to make the test with one instrument. Another objection to this current method is, that it does not possess the accuracy of the voltmeter method; for in order that the three-current method may give accurate results, it is necessary to assume the entire absence of any inductive resistance in the circuit. As the ampère meters usually contain a coil, their resistance is not non-inductive, and they therefore introduce an error.

MODIFICATION.

In order to avoid the objections just stated, a modification is suggested and is shown in Fig. 6. The arrangement is quite similar to the one just described, with the exception that instead of placing an ampère meter in the non-inductive circuit, a voltmeter is placed at its terminals, as shown by $V$. In this case the current in the non-inductive resistance $r$ is evidently $\frac{V}{r}$, and the formula then will be

$$W = \tfrac{1}{2}r\left(A_1^2 - A_2^2 - \left(\frac{V}{r}\right)^2\right)$$

If the voltmeter used in this test be a hot wire instrument, then, since an appreciable current will pass through it $r$ must be taken as the parallel resistance of $c\ d$ and the voltmeter together. It might be observed, however, that there is no necessity to know either of these resistances separately, since the value of $r$ can be determined very readily by calibrating the instruments relatively as follows:

First break the circuit of $c\ d$ and also that of the voltmeter, and compare the deflection of the ampère meter $A_3$ with that of $A_1$. They ought to be alike, but if there is an error, note it. Second, close the circuit of $c\ d$ and of the voltmeter and break the circuit $a\ b$. $A_3$ is now in series with the parallel circuit of $c\ d$ and the voltmeter and will measure the current in the two together. The value of $r$ is then readily calculated, since it is equal to the volts read at $V$ divided by the ampères read at $A_3$.

This latter method appears in general to be the best of all of the above, as there are the least objections to it, and the errors can all be corrected if the work is to be very accurate. The choice between these methods, however, will depend upon the particular conditions, and therefore it cannot be said that any one of the methods is best under all circumstances.

## New Building of the Bell Telephone Company in Toronto, Can.

The new building of the Bell Telephone Company is nearing completion, and when it has been taken possession of in it will be found a switchboard capable of accommodating 6,000 subscribers and the largest in the world. It is interesting to electricians and other scientists to visit this new structure at the present time, as the wires for the installation of incandescent lights in the building are now being laid under a system entirely new in Canada. It is called the interior conduit, or drawing-in system. All wires are rubber-covered, and then they are encased throughout the building in a thoroughly insulated fireproof and waterproof tube. They are arranged in such a way that any wire or section may be drawn out of these tubes from central distributing points and new wires inserted when a break occurs. These pipes resemble gas pipes, and serve as a mechanical protection to the wires, so that difficulties by way of insulation heretofore are entirely removed. These pipes will be kept free from all moisture by being buried in a cement bed twelve inches deep.

## The Elements of Practical Electricity.*

BY DR. LOUIS BELL.

To determine the reduction factor of your galvanometer by means of electric deposition of copper is a process requiring a little preparation and a considerable amount of care. In the first place you must arrange a cell to hold conveniently the plates on which you are to deposit your copper. Prepare two flat copper plates 2 × 4 inches and clean them very thoroughly so that the surfaces are smooth and bright; next take a piece of board some three inches square and make two thin saw cuts crosswise of it about three-fourths of an inch apart and extending nearly across the board. Use a fine and thin saw so that when your copper plates are slipped into the saw cuts they will be held in position quite parallel to each other. Now prepare from a bit of spring brass two little clips, so that when they are slipped over the edge of the copper plate they will hold it quite firmly. To each of these clips solder a wire to lead to your battery or galvanometer; set up your Daniell cells and connect to the terminals of each of them one of your largest resistance coils and let them run for some little time in order to get them into steady working order. Make a considerable quantity of the regular copper plating solution used in copying the seal and similar work, and fill a tumbler nearly full of it. Put the plates through the slots in the bottom so that they will project far down into the tumbler when the bottom is placed across its top, and retain them in that position by springing your clips over them.

Now set up your galvanometer and connect one of your cells to it through the electrolytic cell, noting the deflection. It is best for your purpose that this should be as near 45° as possible. If one cell does not give the requisite deflection try the two in series, if the deflection is too much cut it down by putting one of the resistance coils in circuit.

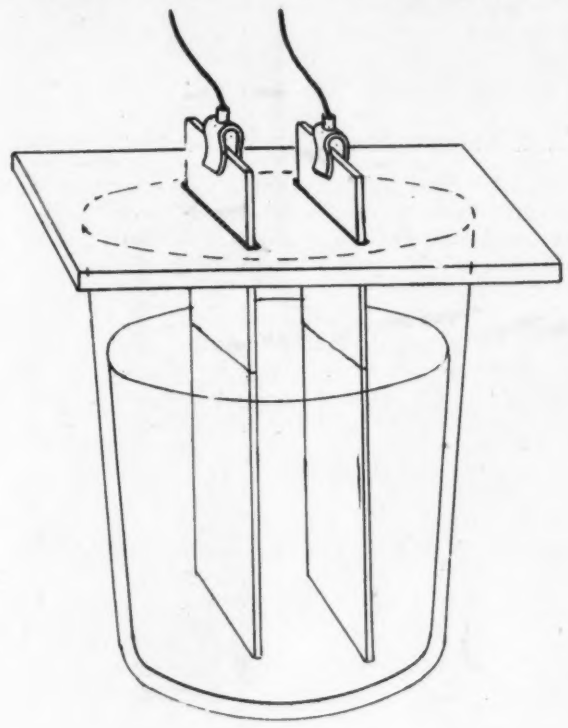


FIG. 30.—WORKING ARRANGEMENT OF AN ELECTROLYTIC CELL.

You ought by this time to have half a dozen little wire connectors—mere bits of brass tube with a screw in each end to grip the two ends of wire which you desire to connect. Having made your deflection as near to 45° as the batteries will permit, remove the copper plates from the solution and from their position in the board, clean them again, dry them in a current of hot air, and weigh them very carefully. The more sensitive the scales and the finer the weights employed the better will be the result; the plates should certainly be weighed to within half a grain.

The working arrangement of the electrolytic cell is shown in Fig. 30.

Now replace the plates in the cell, disconnect meanwhile the wire from the galvanometer, then complete your circuit through the galvanometer, noting to the second the exact time at which this connection is made. Let the current flow for three or four hours, taking galvanometer readings say every 10 minutes. The current will probably remain nearly enough constant so that by averaging the readings you can get a pretty correct value for the average current. Disconnect your circuit, noting exactly the time at which it is done, so that you can find the precise number of minutes and seconds during which the current has been depositing copper. Now remove the plate upon which the copper has been deposited—handling it as little as possible—wash it very gently in water, and then rinse carefully in distilled water or rain water, dry it in a current of hot air, then weigh it. You now have secured enough data to determine the current, and—since you know the deflection produced—the reduction factor of the galvanometer.

You know the weight of copper that has been deposited, the number of seconds during which the current has been flowing, and the tangent of the angle of deflection. Remembering that a current of one ampère deposits .326 milligramme of copper per second you can figure out the current in ampères that must have been flowing to produce in a given time the deposition of copper that you have found.

Then, since $K\ H$ multiplied by the tangent of the angle of deflection equals that current, you can at once find the value of $K\ H$, which is the reduction factor of your galvanometer, and will be—so long as the galvanometer remains nearly in the same place and is undisturbed by neighboring iron—always available for the determination of any unknown current that you may pass through the instrument. If scales of sufficient delicacy are not available—though generally they are in every place where there is a good apothecary's shop—but an incandescent light circuit is at hand you can get your reduction factor in a very rough way by putting the galvanometer in series with an incandescent lamp. If this is an Edison lamp, for example, or any other lamp of the variety known as 110 volt lamps, the current which it will allow to pass through your galvanometer will be very nearly .6 of an ampère, which again gives you the current corresponding to a certain deflection, and hence the reduction factor of your galvanometer.

If it should happen that your galvanometer is so adjusted that the deflections—when the same current is passed through it in opposite directions—are not equal, you will have to reverse the current through your galvanometer each time you take a reading of the deflection so as to obtain readings from each end of the needle in both directions of deflection. This reversal can be accomplished simply by exchanging the wires in the binding posts of your galvanometer, taking care not to disturb it in the process. Of course the time during which the wires are disconnected in making this change must be noted and subtracted from the total time between originally making circuit through your electrolytic cell and the time when you finally break it to take out the plates.

Having now obtained some idea of the unit of current and its properties, you are ready to make the acquaintance of some other electrical units.

You have noticed all along that we have been speaking of a current of electricity as though it was something which is flowing, and in a certain way this view of the case is correct. If, however, we look at it in this light, we must consider that if there is anything flowing—whether it be a substance or not—a certain quantity of it must flow in a given time, just as a certain number of gallons of water would flow from a pipe in a given time. There is a special name for the quantity of electricity that is represented by a current of one ampère for one second. This unit of quantity is called one *coulomb*, and you will see that it can be traced back to the same fundamental units of length, mass and time which turn up in all our calculations.

Now you can readily see from your experiments that different batteries or that two batteries in series will cause a greater or less flow of electricity through the same wire.

In other words that their power of forcing current along that wire varies just as in a similar way the flow of water through a pipe measured in gallons per minute depends on the pressure under which the water is flowing—on the "head" of water. Now there is something in electricity that corresponds roughly to "head" of water, and this represents the force possessed by a given battery to set up a current through a particular resistance. It is, in fact, electrical difference of pressure, or difference of potential, as it is more frequently called, and the force corresponding to pressure which enables the battery or dynamo to set up a current through a given resistance is known as electromotive force, which is in its relation to current very closely analogous to pressure of water in relation to flow of water.

Just as water flows from higher to lower levels, so electricity flows from points of higher to points of lower potential under the influence of electromotive force, that is, electrical pressure. We may follow the analogy a little further, and say that just as work is required to force water against a given water pressure, in other words up to a given head, so electrical work must be performed to force the current to flow against given electrical pressure. Difference of water pressure can be accurately measured by the force necessary to be exerted in order to displace a certain quantity of water against that pressure; in the same way electrical pressure can be measured by the force required to cause a given quantity of electricity to flow against that pressure. So that just as hydraulic difference of potential can be measured by the work done in causing a unit quantity of water to move against it, so difference of electrical potential can be measured by the work done in conveying a unit quantity of electricity against a given pressure.

Now in ordinary work we have a familiar unit of work known as the foot-pound, and we could measure the number of foot-pounds required to force up one gallon of water against a known number of feet. Just so we have a unit of work in the C. G. S. system of units to correspond in general character precisely to the foot-pound, and it is the work required to exert a push of one dyne through one centimetre. We might very properly call it a centimetre-dyne—a term which would correspond to "foot-pound;" for convenience a special name is given it and the C. G. S. unit of work is called one *erg*. Since we know the relative length of the centimetre and foot, and the relation also between the pound and the dyne, it is evident that we can express very exactly the relation between the erg and the

* Continued from THE ELECTRICAL WORLD, Dec. 26, 1891.

foot-pound. A foot-pound equals 13,562,600 ergs, and you will see from this that the erg is a very inconveniently small unit for any ordinary purpose and so a multiple of it has been adopted as more generally convenient for measurement; this multiple is 10,000,000 times the erg, and is known as the *joule*. One foot-pound, therefore, equals 1,356 joules.

Now to come back to this electrical C. G. S. unit of difference of potential—in other words, of electrical pressure—*it is that difference of electrical pressure which will require one erg of work if one coulomb of electricity is carried against it.* This would be quite analogous to defining unit head of water as that head which would require one foot-pound of work to be done in order to move one gallon of water against it. Inasmuch as the erg is so very small compared with our ordinary quantities, the C. G. S. unit of electrical pressure just mentioned is never used, and only a multiple of it is put into practical employment; this is 100,000,000 times the C. G. S. unit ust mentioned, and is called one volt. Its value, you see, is such that one coulomb of electricity conveyed against an electrical pressure of one volt requires an expenditure of one joule of work. You will understand this relation better by remembering that the ampère is a tenth of the larger C. G. S. unit current, and hence one coulomb is a tenth of what might be called the theoretical unit of quantity. This accounts for the missing factor of ten between the 100,000,000 units of pressure that constitute a volt and the 10,000,000 ergs that constitute a joule.

The volt, our regular working unit of pressure, it is not very easy to determine directly. It happens to be not far from the electrical pressure produced by one Daniell cell, in fact the electromotive force of a Daniell cell is about one and a twentieth volts. We might, however, get at the volt in a more scientific way through the work done by a given flow of electricity. We have already seen that one joule equals one volt-coulomb; now the joule is the unit of work, and, as is well known, there is a perfectly definite relation between work and heat. The researches that have been made on this subject show that 1,047.30 joules are required to raise the temperature of one pound of water one degree Fahrenheit. Now, from what experiments you have already tried you will understand that the flow of electricity through a wire heats it, so that the work done by the electrical pressure in forcing current through a resistance appears as heat.

It is possible to measure the quantity of heat produced by a given current through a given wire by allowing the wire to heat a given quantity of water a known amount. Hence, since the heat goes on nearly equally all along the wire, if a known current were passed through a wire so arranged that the heat produced could be measured, for each pound of water raised one degree Fahrenheit in temperature by the current there would be 1,047.30 joules of work done by that current. Now one joule equals one volt-coulomb; to establish the relation between the heat produced and the volt, it is more convenient if we consider not the quantity of work done but the rate at which it is done. Our familiar rate of doing work is the horse-power, 33,000 foot-pounds per minute; in the C. G. S. system we have a similar convenient unit of work done, which is one joule per second, called one "*watt*." Just as there is a relation between the joule and the foot-pound so there is an exact relation between the watt and the horse-power; 746 watts equal one mechanical horse-power; but since one joule equals one volt-coulomb and the ampère equals one coulomb per second, one watt equals one volt-ampère. Hence there is a direct relation between mechanical horse-power and the electrical units of measurement the volt and the ampère. If a dynamo gives, for example, 10 ampères at 100 volts pressure, its rate of doing work, measured electrically, is 1,000 watts, about 1¼ h. p.

But to return to the determination of the volt by the heat produced, if we could imagine a wire so arranged that the rate at which it gave heat to water could be definitely measured and a current of one ampère was allowed to flow through it, then we could determine the difference of potential between its ends by the rate at which heat was given out. If the energy expended in the wire was emitted as heat in the surrounding water at the rate of one watt, then the difference of electrical pressure would be one volt. Or, if we could determine from the heat given out the number of watts representing the rate at which energy is being expended in the entire wire, we should have one volt difference in pressure between its ends for each of these watts. The experimental determination would be too difficult for any practical purpose; it could, however, be performed if necessary, and, indeed, has been made with a high degree of accuracy.

*(To be continued.)*

## Electricity in Mining.—VI.

### VENTILATING.

The importance of good ventilating in all mines is second in importance to no other feature of mining appliances. Air must be supplied in order to sustain life, and electricity being the only medium through which this can be secured with absolute certainty at all times and in all places where it is required is recognized as of the greatest value.

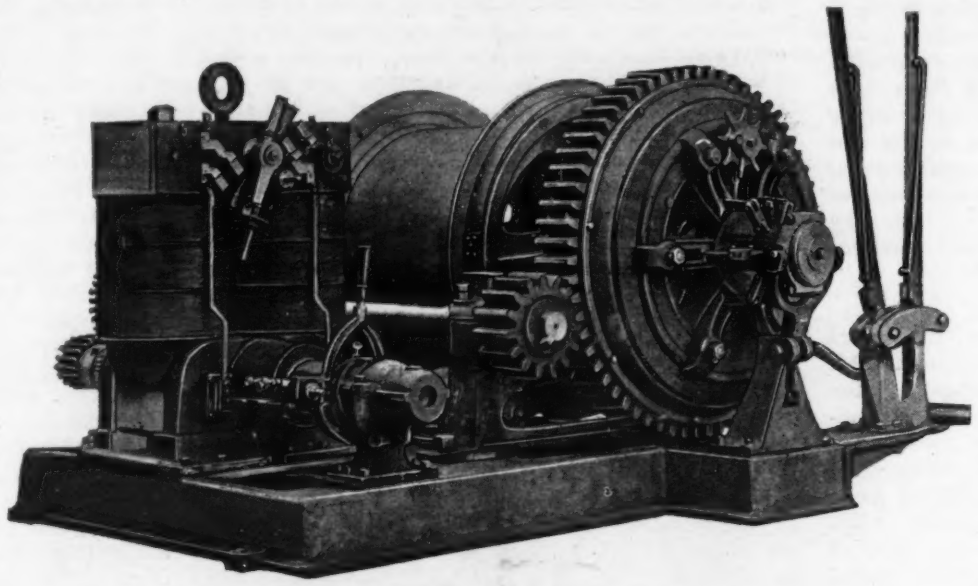


FIG. 1.—EDISON-WEBER FRICTION CLUTCH HOIST.

Motor driven fans for stores and offices were among the first applications of the electric motor to useful work. Requiring but a small amount of power, these devices could not very well be operated by any other power. The extreme flexibility of the current and the self-contained nature of the motor made it possible to place the fans in any desired position without any loss of efficiency, and hundreds of them were so arranged. This simple yet perfect power application has been duplicated in mining work, adding another triumph to electricity for mining operations.

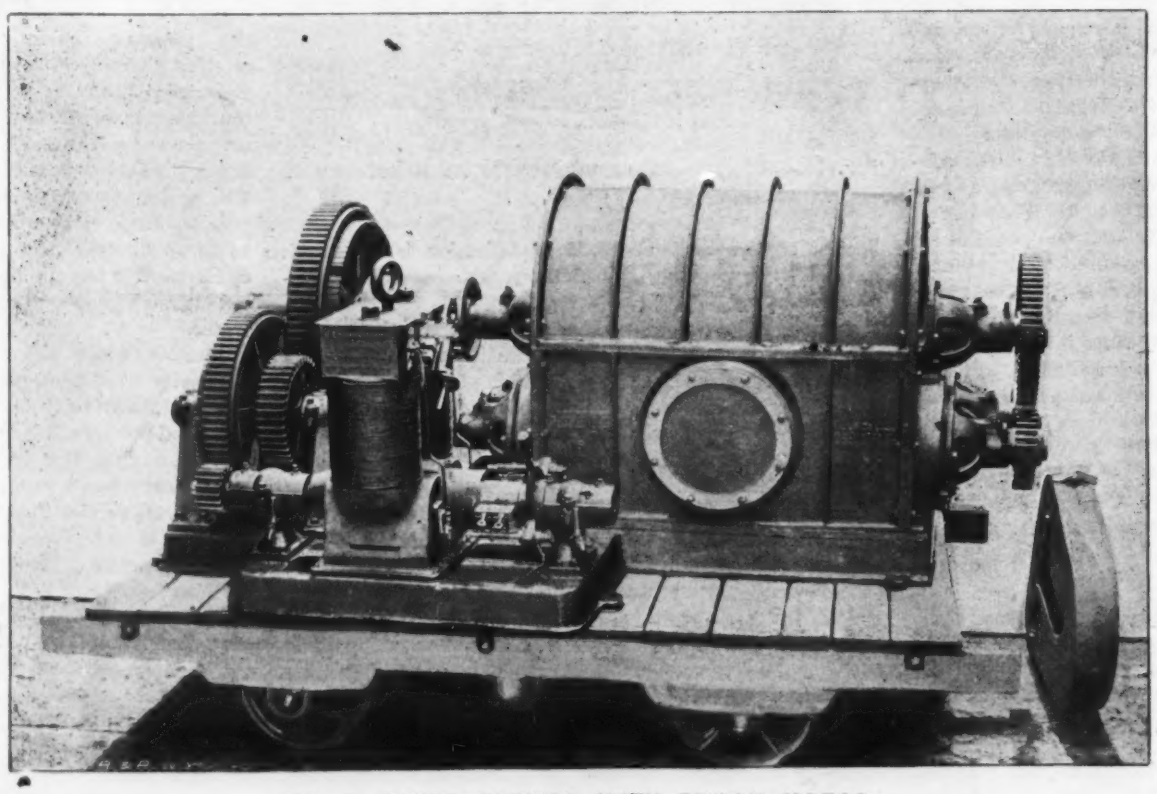


FIG. 2.—BAKER BLOWER WITH EDISON MOTOR.

The fan can be started or stopped by the single movement of a switch which throws the motor in or out of circuit. This arrangement will enable the motor to be placed at the mouth of a shaft at a great distance from the driving power, and at other places not easily accessible by any mechanical connection. This controlling switch need not necessarily be located at the motor, but can be placed within easy reach anywhere between the fan and the junction of the supply branch with the main conductor.

An excellent electric fan equipment is found at opening No. 3, at Jobs, O. Here a 15-h. p. Edison motor is operating a six-foot fan. This makes 220 revolutions per minute, and delivers 50,000 feet of air per minute. The motor requires from 55 to 58 ampères, the pressure at the generator being 250 volts. This fan is located 1,600 feet from the mouth of the mine, and 2,000 feet from the power house. The conductors are ordinary No. 0 wires. Ordinary glass insulators are used, being fastened to plugs driven into the side of the gangway.

The motor requires hardly any attention. The man who attends to the pumps visits it from time to time and keeps it properly oiled. It runs from 7 in the morning until 12 at noon, stops till 1, runs till 5, stops till 7 and runs again until 4 in the morning, about 18 hours a day. As they already have a superabundance of air the fan is not run up to its full capacity. Before its adoption the furnace in use gave such a poor air circulation that the mine inspector threatened to shut down the mine unless this defect was remedied.

In opening No. 2 of the same mine a five-foot fan is driven by a 15-h. p. Bain motor, being stationed 4,000 feet from the generator. The advantages of placing a fan in the mine near new workings are numerous. The most important point is that the men receive a fresh supply of air at all times instead of getting air that has first passed through all the old workings and contains more or less black damp.

At Willock Station, in Pennsylvania, a 12-foot fan has been installed at the bottom of a 75-foot shaft. This fan is operated by a Tesla motor, and delivers 50,000 cubic feet of air a minute. As with the fan at Jobs mine, very little, if any, attention is required for the operation of this motor. Being perfectly automatic, all that is required is an occasional oiling, which is attended to by a man who looks after some other work about the mine.

Fig. 2 shows an ingenious application of the Edison motor to the well known Baker blowers for ventilating mines. This is but one of the many patterns which have been perfected for this work.

### HOISTING.

The necessity for hoists and their adaptability to mining work is well known. The manifold advantages of electric power, so repeatedly pointed out in this series of articles, are embodied in the electric hoist to a greater degree than many other appliances. It is more compact and much more easily operated than the steam hoist, while the depreciation from wear and tear is greatly reduced. Possessing these qualities, the electric hoist is filling a great field in mine and milling work, where a convenient and portable hoist is needed. It can be operated from the lighting or power circuit already installed, and is suited to the rapidly changing conditions of the work.

The first electric hoist to be perfected and placed on the market was that developed by the Thomson-Van Depoele Electric Mining Company, which has already been fully described in The Electrical World.

Fig. 1 shows the new Edison-Weber Friction Clutch Hoist, now being operated by the Caroline Mining Company, of Ouray, Colo. The motive power is a 30-h. p. standard Edison motor, geared through intermediate shafting to a large clutch gear on the drum shaft. The drum is geared to a shaft which engages the gear by means of a friction clutch. This clutch is actuated by an upright hand lever, and a smaller lever is used to operate the motor switch connected with a suitable resistance box. These levers are so arranged that the motor can only be started when the clutch is engaged. The drum is operated with a hand brake and also foot lever, both convenient to the person standing by the lever.

One great advantage of this apparatus is its compactness, as is evident from the following figures:

Bed plate, 5 feet 10 inches square.
Clear space required over all, 81 inches by 90 inches.
Length of drum, 25 inches. Diameter of drum, 30 inches.
Extreme height of levers, 60½ inches.

The efficiency of the machine is 75 per cent. The drum will wind in one layer 260 feet of ⅝-inch rope. With a current of 785 volts the speed of the hoist is 375 feet per minute, at which rate it will raise 1,500 pounds.

This type of hoist is made in different sizes, as will be seen from the data in the accompanying table.

Several electric hoists are now operating in the Aspen, Colo., mining region. Among the prominent mines using them are the Aspen Mining and Smelting Co., the Aspen mine, the Regent mine and Taylor & Brunton.

An interesting feature of electric hoisting is found at the mine of the Morgan Run Coal and Mining Co., Morgan Run Pa. Owing to a low tipple at this mine, all nut and pea coal has to be elevated 30 feet to raise it above the screens and carry it into the proper chutes. This work is at present performed by a 4-h. p. Schlesinger motor. The elevator chain runs at a speed of 300 feet a minute and carries 40 buckets 6 × 14 in. The coal is fed into the buckets from the side.

| Rating of hoist. K. w. | Available h. p. for one drum. | Diameter of drum. Ins. | Estimated shipping weight complete. | | | | Electric bucket elevator hoist with sprocket wheel. |
|---|---|---|---|---|---|---|---|
| | | | Single drum. Lbs. | Double drum. Lbs. | Three drums. Lbs. | Four drums. Lbs. | Estimated weight complete. Lbs. |
| 3 | 2.34 | 8 to 20 | 2,255 | 3,455 | 4,655 | 5,855 | 1,855 |
| 6 | 4.80 | 8 to 20 | 2,635 | 3,835 | 5,035 | 6,235 | 2,235 |
| 8.5 | 6.80 | 8 to 20 | 2,920 | 4,120 | 5,320 | 6,520 | 2,520 |
| 12 | 10.2 | 8 to 20 | 3,365 | 4,565 | 5,765 | 6,965 | 2,965 |
| 15 | 12.75 | 8 to 22 | 4,415 | 5,802 | 7,190 | 8,577 | 3,953 |
| 20 | 17.6 | 8 to 24 | 5,475 | 7,275 | 10,970 | 13,270 | 4,875 |
| 25 | 22.22 | 8 to 26 | 6,770 | 8,870 | 7,970 | 9,170 | 6,070 |
| 30 | 27.70 | 8 to 28 | 8,210 | 10,760 | 13,310 | 15,860 | 7,360 |
| 45 | 40. | 8 to 30 | 11,770 | 14,770 | 17,770 | 20,770 | 10,770 |
| 60 | 54. | 8 to 48 | 17,590 | 27,340 | 28,090 | 32,340 | 15,840 |
| 100 | 87.9 | 8 to 48 | 24,500 | 34,250 | 35,000 | 39,250 | 22,750 |

CONCLUSION.

As outlined in the first article, it has been the effort of THE ELECTRICAL WORLD not to treat of electricity in mining from a purely theoretical or scientific standpoint, but rather to review what has actually been done by American electricians in this very important branch of the industry. The progress that has been made is more than encouraging when compared to the length of time experience has demonstrated to be necessary to bring any new feature of electrical practice into good working order.

Owing to the widely scattered nature of the mining fields it has been impossible to obtain complete data of what electricity has actually accomplished in this direction, so that we shall have to leave to subsequent issues detailed accounts of some prominent mining equipments where the agency of electricity has brought unexpected advantages and marvelous results.

## Rapid Transit in Great Cities.*

BY ST. JOHN V. DAY.

In most cases lines of communication requisite to meet the pressure of city traffic must, of necessity, be carried through some of the principal streets, and as these are frequently crowded with pedestrian, equestrian and vehicular traffic, a surface railway is in most cases out of the question, and this for two reasons.

First.—Because it is impossible to obtain rapid transit on the same level with an interfering slow transit in several different directions.

Second.—Because of the danger to human life which every system of railway on the surface of the street involves.

From these considerations it follows that a safe and adequate system of rapid transit can only be carried out by being entirely separated from the street traffic, which means that the tracks must be either raised a sufficient height above the street level or carried beneath that level.

These conditions have developed on the one hand the tunnel system, which is in operation in London and known as the Metropolitan Railway, worked with a peculiar construction of steam locomotive, and the more recently constructed City & South London Railway, wherein an iron and cement lined tunnel on what it has become the fashion to call, although erroneously so, Mr. Greathead's plan, with electrically operated trains. On the other hand the evolution has resulted in the elevated railway.

Before, however, either the tunnel or elevated railway were resorted to for this class of traffic, surface railways of different kinds were tried, and naturally so, as the immediate outcome of current experience in regard to transinsular or transcontinental railway traffic.

It is interesting to note that the first practical attempt at this was made in this country more than half a century ago, namely, in 1834, when in the city of New York two lines of horse railways were first operated on some of the principal thoroughfares.

These lines developed an extraordinary statistical fact, namely, that the traffic immediately available for such railways is many times in excess of the population.

During the first year of their operation the New York horse railways carried 6,835,548 passengers, while the population then was 515,547 persons, showing the number of passengers to be about thirteen times the population. A few more statistics in this connection are available to our present purpose. In 1836, or two years later, the number of horse lines in New York was doubled, and the traffic increased to thirty-one times the population. In 1860 six lines of surface roads were in operation in New York City, when the ratio of passengers to population rose to forty-seven. In 1865 the number of lines had doubled, or reached the number of twelve, when the traffic amounted to 82,000,000, or eighty-three times the population. A decade later, or in 1875, the number of street railways had risen to nineteen, when, with a doubled population, the ratio of passengers carried reached a hundred and sixty times. Before this, however, through the growth of the suburbs, the necessity of rapid transit had begun to press itself upon crowded business communities in other countries, particularly in London.

Up to the year 1862 passenger traffic of the kind we are considering had been carried on in London by horse omnibuses, but even before then my friend, the late eminent engineer and shipbuilder, Mr. J. Scott Russell, F. R. S., had attempted the solution of the problem in the city of Glasgow by a steam omnibus, which ran for some time between that city and the suburban manufacturing town of Paisley. This, however, through frequent breakdowns, frightening of horses, and ending in a boiler explosion, was abandoned after about 12 months' use. The General Omnibus Company of London in 1862 was carrying 41,068,000 passengers, and when the Metropolitan Railway was opened it was expected by the promoters of that line that a great portion of the traffic which that railway was constructed to compete with would be taken away from the omnibus company. Such, however, was not the case, for the facility which the Metropolitan Railway developed for reaching the suburbs immediately produced a rapid growth in the number of passengers for being moved to and from those districts. In 1870 the Metropolitan District Railway, as well as some of the surface tramways, was open to traffic, and although in direct competition with each other, the passengers carried rapidly increased in number until 1884 the total number of passengers reached 308,821,000, of which 75,113,000 were carried by the omnibus company, 75,926,000 by the Metropolitan, 38,521,000 by the District Railway, and 119,261,000 by the tramways.

In the 20 years from 1864 to 1884 the population of London increased 36 per cent., while the passenger traffic increased 470 per cent. At the middle of this period, when many of the defects and dangers of operating passenger trains by steam locomotives in the long tunnels of the Metropolitan Railway had become well recognized, a new movement took place in the city of New York, culminating in the Manhattan Elevated Railway, which was opened for traffic in 1878. The traffic returns for that city after the elevated railway was built, although designedly constructed to compete with the pre-existing horse lines, showed that the ratio of passengers to population had reached to 175. In 1885 23 lines were in operation in the city of New York, when this ratio had risen to 213, while in 1890 it had reached 405,590,159 passengers. Of this immense number 191,611,382 were carried by the elevated railway; that is to say, an increase of more than 76,500,000 of passengers in five years. The balance, namely, 213,978,931, were carried by the horse railway, which shows an increase of over 4,000,000 in the same five years, or about one-twentieth of the increase in the elevated railway traffic.

Underground conveyance of many kinds is being urgently pressed forward at the present time, and especially one having, like the elevated system I have suggested four tracks, two for express trains and two for way traffic, each track being placed in an independent tunnel, therefore requiring four tunnels.

Even if I omitted to notice the natural dislike which most persons have to descend out of daylight and fresh air into tunnels, however well these may be illuminated and ventilated, ho vever luxuriously equipped for the passenger train service, there is an inherent dread of being the subject of some one or other of the many catastrophes which railway records are but too full of, as having happened in tunnels. These are, however, overlooked by the promoters of tunnel schemes. Especially have they been misrepresented by Mr. Sterne, the New York agent of the Greathead railway system, in an article published in the *Forum* of August last, wherein too the same gentleman does not hesitate to hazard some unblushing misstatements in regard to elevated railways. Let us give Mr. Sterne a little of our attention. In regard to the cost of the works for the four-tunnel Greathead road proposed for the New York City line, Mr. Sterne, when before the Rapid Transit Commission, estimated the cost of a single track tunnel, cut in the rock upon which it is assumed New York City stands, continuously, at about one million dollars per mile of single track. Four of these tunnels, two for rapid transit, the other two for way traffic, would therefore cost four million dollars per mile, including, as I understand, the extra excavations for underground stations and the elevator shafts for connecting these with the surface.

With all the advantages which we possess to-day in the practical uses of electricity, not only for operating trains, but for lighting them also, as well as tunnels, and for working elevators, it is open to serious doubt whether, when to the foregoing four million dollars per mile is added the further cost of generating stations, motor cars, passenger cars and the copper for the conductors, such a system could be constructed and operated so as to make a satisfactory return on the investment, at a fare which the traveling public would be willing to pay.

It is certain indeed that when, as is the fact in the United States at least, the public has for so many years been accustomed to be carried to the farthest limits of every important city for a five-cent fare, upon the comparatively cheap construction of street railways hitherto used for this sort of traffic, it would be very unwilling from that point of view to encourage the adoption of so costly a scheme as the four-tunnel electrically operated one, since its adoption would imply resort to higher charges for travel.

Instead of raising the fares, the tendency is to lower them, and in some of the municipal legislatures—for instance, in that of Chicago—proposals have been made to cut the fare down to three cents. Upon an ordinary surface steam railway in the United States it is found that a fare of one cent per passenger mile is the least that can be made to pay. For municipal railways the passenger mile condition has not, in this country thus far, come into operation, but a uniform fare for variable distance, which introduces the certainty that with such a very costly system of railway construction for municipal traffic long distance passengers cannot pay.

In deciding upon any system of municipal railway communication, the fare which the public is willing to pay must not be lost sight of. It is one of the leading factors in determining the amount of capital which can be properly invested in such undertakings, and because of that this factor principally governs the engineering character of the works, that is to say, the engineering design must be such that while fully adapted for the prospective traffic it must not cost more than a predetermined limit per unit, say per passenger mile or per mile length of structure. When, then, we add to the foregoing four million dollars

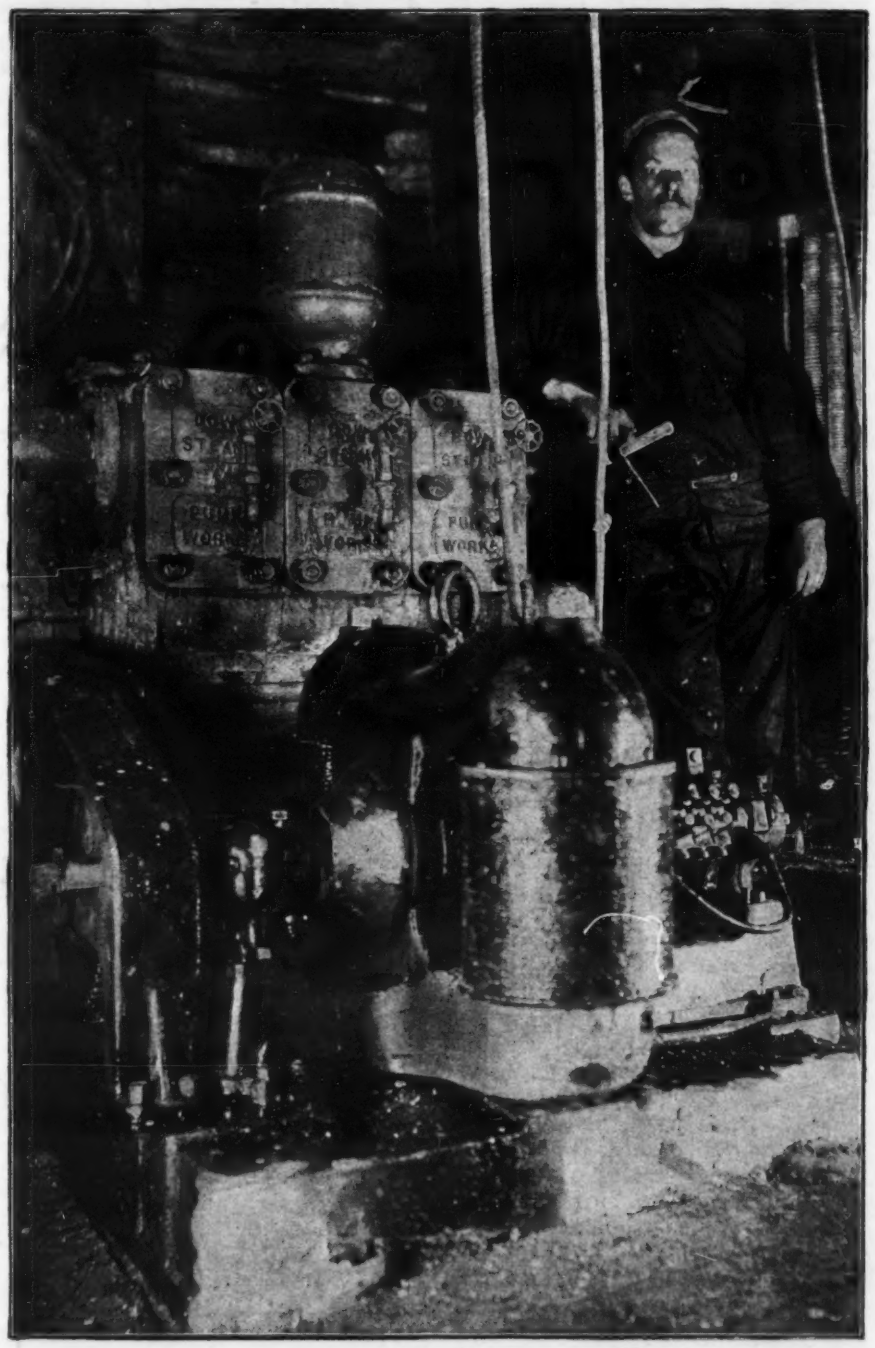


FIG. 3.—EDISON MINING PUMP IN OPERATION.

* Abstract of a paper read before the Chicago Electric Club, Dec. 21, 1891.

per mile the cost of the electric plant sufficient to operate the intended traffic, we reach figures which are startling.

This would have to be doubled for equipping a four-track tunnel, thus bringing up the first cost of the four-track tunnel scheme to at least $5,000,000 per mile without including in the estimate numerous essentials which do not enter into the list of requisites for any above ground railway, whether elevated or surface. For example, there is not included in this estimate the cost of the elevators nor the electric plant for continuous lighting of the tunnels, stations and trains.

There is still another very serious point which arises in considering any system of underground railway operated electrically by continuous conductor, which, so far as I know, has not previously had public attention directed to it, namely, what is to happen in a tunnel with numerous trains in it, when a breakdown or other occurrence causing a stoppage of the electrical plant takes place? No electrical railway plant has as yet been devised which does not sometimes, and always very unexpectedly, stop, through the burning out of an armature, and from several other causes.

Such occurrences either produce a temporary stoppage of the entire traffic by the trains becoming congested together or otherwise interfered with when happening on above ground railways. But as with these there is always abundance of free space and light, each train is easily dealt with, and the passengers can at once alight, so that the inconveniences caused by such breakdowns on above ground roads are reduced to a minimum.

Not so, however, in the Greathead circular tunnel, wherein the carriages are designed to have as little free space as possible between them and the tunnel walls or lining.

It would be impossible for passengers to alight from carriages in these tunnels excepting at the stations.

Not only a single train but many trains at the same instant will be in the same tunnel, with their loads of live humanity, powerless, helpless to escape, so that it is difficult to foresee how, in view of such casualties, which may be looked upon as among the certainties of any electrically operated tunnel system, the imprisoned passengers are to be extricated in any comparatively short time, even in the way tunnels where it is proposed the stations shall be at short distances apart—say of two, three or four blocks. This pre-supposes the case of a failure of the train propelling part of the electrical plant only, but then the illuminating part of that plant is liable to break down also. This would add darkness to the horrors of the imprisoned passengers. Such breakdowns occurring in the way traffic tunnels would be terrible indeed; in the express or rapid transit tunnels they would be appalling.

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## Chronological History of Electricity, Galvanism, Magnetism and the Telegraph, from B. C. 2637 to A. D. 1888.—Part I.*

BY P. F. MOTTELAY.

A. D. 1788.——Barthélémy (Jean Jacques), who, after completing his studies in a French seminary of Jesuits, succeeded Gros de Boze as keeper of the king's cabinet of medals, publishes, in four volumes, at Paris the first edition of his "Voyage du Jeune Anacharsis." In this well known work, begun by him in 1757, and translated into English under the title "Travels of Anacharsis the Younger in Greece," Barthélémy alludes to the possibility of telegraphing by means of clocks (*pendules*, not *horloges*), having hands similarly magnetized in conjunction with artificial magnets. These were "presumed to be so far improved that they could convey their directive power to a distance, thus, by the sympathetic movements of the hands or needles in connection with a dial alphabet, communications between distant friends could be carried on."

See "Correspondance inédite de Mad. Du Deffaud," vol. II., p. 99; letter of J. MacGregor in *Journal Society of Arts*, May 20, 1859, pp. 472, 473.

A. D. 1789.——Adriaan Paets Van Troostwijk and Jean Rodolphe Deiman, Dutch chemists, associated for the purpose of scientific research, complete the experiments of Lord Cavendish and announce, in the *Journal de Physique*, their discovery of the decomposition of water through the electric spark, which latter is conveyed by means of very fine gold wires. As is well known, water is by this means resolved into its two elements of oxygen and hydrogen, both of which assume their gaseous form.

The electric machine they employed was a very powerful double-plate one, of the Teylerian mode of construction, causing the Leyden jar to discharge itself 25 times in 15 revolutions.

See "Mém. de la Soc. de Phys. Exp. Rotterdam," tome VIII.; *Journal de Physique*, vol. XXXIII.; Noad, "Manual," p. 161; "Encyl. Brit." vol. VIII., 1855, pp. 530–565; "Biog. Universelle," vol. X., p. 282; De La Rive, "Electricity," vol. II., p. 443; Wm. Henry, "Elements of Experimental Chemistry," London, 1823, vol. I., pp. 251, 252; Delaunay's "Manuel, etc.," 1809, pp. 180–183; "Verhandl. van het Genootsch te Rotterdam," ("Mém. de la Soc. de Phys. Exp. de Rotterdam") vol. VIII.; Poggendorff, vol. I., p. 1,555; Dove, p. 243; G. Carradori (Brugnatelli's *Annali di chimica*, vol. I., p. 1); John Cuthbertson, "Beschreibung einer Elekt. . . .," Leipsic, 1790.

A. D. 1790.——Reveroni—Saint-Cyr (Jacques Antoine, Baron de), French Colonel and author, best known by his very interesting work, "Mécanismes de la Guerre," proposes an electric telegraph for the purpose of announcing the correct drawings of lottery numbers; no satisfactory information as to its construction, however, appears obtainable.

See Fahie, History, etc., London, 1884, p. 96; Etenaud, "La Télégraphie Electrique," 1872, vol. I., p. 27; *Sc. Am. Supp.*, No. 384, p. 6,126.

A. D. 1790.——Mr. Downie, master of Her Majesty's ship "Glory," makes a report on local attraction wherein he observes "that in all latitudes, at any distance from the magnetic equator, the upper ends of iron bolts acquire an opposite polarity to that of the latitude," an observation, Harris remarks, in accordance with Marcel's experiment (A. D. 1702).

"I am convinced," says Mr. Downie, "that the quantity and vicinity of iron, in most ships, has an effect in attracting the needle; for it is found by experience that the needle will not always point in the same direction when placed in different parts of a ship; also, it is very easily found that two ships, steering in the same course by their respective compasses, will not go exactly parallel to each other; yet when their compasses are on board the same ship they will agree exactly."

See William Walker "The Magnetism of Ships," London, 1853, p. 20; Harris, "Rudim. Magn.," 1852, Part III., page 161.

A. D. 1790.——Tralles (Johann Georg), a German scientist, is the first to make known the negative electricity of cascades. This he communicates through his "Uber d. Elektricität d. Staubbachs," published at Leipsic.

In the Report on Atmospheric Electricity of Francis J. F. Duprez, translated from the Memoirs of the Royal Academy of Brussels by Dr. L. D. Gale, we read that one day while in the Alps, opposite the cascade of Staubbachs, near the Sauterbrunnen, Tralles "presented his atmospheric electrometer, not armed with the metallic wire, to the fine spray which resulted from the dispersion of the water. He immediately obtained very distinct signs of negative electricity. The same effect was exhibited at the cascade of Reichenbach. Volta, a short time after, verified the correctness of this observation, not only above the great cascades, but also wherever a fall of water existed, however small, provided the intervention of the wind caused the dispersion of the drops. The electricity always appeared to him, as it did to Tralles, negative. Schübler repeated the same experiments in his journey to the Alps in 1813. He observed farther, that this negative electricity was very strong, since it became perceptible at a distance of 300 feet from the cascade of Reichenbach; and at a distance of 100 feet his electrometer indicated 400 and even 500 degrees. . . . Tralles attributed it at first to the friction of the minute drops of water against the air; but soon after he thought, with Volta, that the cause was to be found in the evaporation which the same minute drops experience in falling. . . ."

The Italian physicist, Giuseppe Belli, who published at Milan, during 1836, "Sulla Elettricità negativa delle cascate," entertains an opinion contrary to that advanced by Mr. Becquerel, and believes "that the electrical phenomenon of the water of cascades is owing to the development of electricity by the inductions which the positive electricity of the atmosphere exercises on the water. The water, he says, is by induction in the negative state, when the atmosphere is, as it is ordinarily, charged with positive electricity. At the moment when this water divides into thousands of minute drops, it cannot fail to carry the electricity with which the electrical induction of the atmosphere has impregnated it to all bodies which it meets."

See "Oeuvres de Volta," vol. II., page 239; Franz Samuel Wilde, "Expériences sur l'électricité des cascades" (Mémoires de Lausanne," vol. III., "Histoire," page 13, 1790, "Bibliophie Universelle," N. S. 1836, vol. VI., page 148; "Biblio. Ital.," LXXXIII., page 32; Schweigger, *Journal f. Chemie u. Physik*, vol. IX., page 358; Tralles, "Beyträge zur Lehre von der Elektricität;" L. W. Gilbert's *Annalen der Physik und Chemie*, vol. XXVIII. for 1808; F. A. C. Gren's *Journal der Physik*, vol. I.) for 1790; Humboldt, "Cosmos," London, 1849, vol. I., page 344, and the reference to Gay-Lussac in *Ann. de chimie et de physique*, vol. 8, page 167.

A. D. 1790.——Eandi (Giuseppe Antonio Francesco Geronimo), an able physicist, native of Saluces (1735–1799), reads, May 10, before the Academy of Sciences of Turin, a Memoir upon Electricity *in vacuo* which is printed in the Collections of that Institution. He studied for the priesthood and entered the Normal College of Turin, where he followed protracted courses of literature under Bartoli and of natural philosophy under Beccaria, becoming the assistant of the latter, whom he finally replaced from 1776 to 1781. He afterward became Professor of Natural Philosophy at the College of Fine Arts, where he gave particular attention to electrical studes, and published on that science, as well as upon natural philosophy generally, several accounts of researches, which, though showing marked ability, were forced aside by the more salient observations of many of his contemporaries.

He bequeathed all his possessions to his nephew Vassali, upon condition of the latter's taking the name of Eandi.

Besides the above, he wrote: "Memorie istoriche, etc.," or "Historical Memoir upon the studies of Father Beccaria," Turin, 1783, which is dedicated to Count Balbi and gives the new theories of electricity, and an "Essay upon the errors of several physicists in regard to electricity," Turin' 1788.

See "Notice sur la vie. , . d'Eandi par Vassalli-Eandi," Turin, 1804; "Biographie Générale," vol. XV., page 589; Larousse, "Dict. Universel," vol. VII., page 5; the Turin Academy Memoirs for the years 1802–1804; Eandi e Vassalli-Eandi, "Physicæ experimentalis, etc.," Turin, 1793–1794.

A. D. 1790.——Vassalli-Eandi (Antonio Maria), Italian savant (1761-1825), nephew of G. A. F. G. Eandi, who was, like his uncle, a pupil of Beccaria, publishes his views concerning the electricity of bodies and regarding other investigations, as well as a report upon experiments made relative to the electricity of water and of ice, which appear respectively in L. V. Brugnatelli's *Annali di Chemica*, vol. I., page 53, in the "Bibl. Fis. d'Europa," vol. XVII., p. 144, and in the third volume of "Mem. della Soc. Italiana."

He was one of the most prolific of Italian writers, his more important essays, which number 160, being written in Italian, Latin and French, and covering almost every leading branch of physical science. One of his biographers tells us, *Il a embrassé, pour ainsi dire, l'ensemble des connaissances humaines*, and that he is one of whom his country may justly be proud.

In his investigations concerning aerolites, which appeared in 1786 ("Memoria . . . sopra il bolidi in generale,") he explains the movements of those bodies more satisfactorily than had previously been done by any scientist. Essays published by him during the same year, as well as in 1789 and 1791, treat of the effect of electricity upon vegetables; then follow his papers relative to Bertholon's "Electricité des Météores," to Haüy's theories and to the meteorological observations of Senebier, De Saussure, Toaldo and Monge, up to 1792, when Vassalli was made professor of natural philosophy at the Turin University. He had also in the meantime carefully looked into the scientific knowledge possessed by the ancients, and was led to believe, as shown in his "Conghietture sopra l'arte, etc.," that they had the means of attracting and directing thunder and lightning. The latter fact has been alluded to in this "Chronological History," under the B. C. 600 entry. (See J. Bouillet, "De l'état des connaissances, etc.," Saint Etienne, 1862.)

He was after this made perpetual secretary of the Royal Academy of Sciences of Turin, then became Director of the Museum of Natural History, as well as of the Observatory situated in the last named city, which position he held at the time of his death.

His other essays treat more particularly of animal electricity, the electricity of fishes, the effects of electricity upon recently decapitated bodies, the application of electricity and of galvanism to medicine, and cover very extended observations on meteorology. He is, likewise, the author of both the "Memoirs of the Academy of Sciences of Turin, from 1792 to 1809," and the "Annals of the Turin Observatory, from 1809 to 1818" (Larousse, "Diction. Universel," vol. XV., page 801); was editor of the "Bibliothèque Italienne," in conjunction with Giulio Gioberti and Francesco Rossi, and is said to have devised an electrometer superior to that of Volta.

See Vassalli-Eandi, Giulio (or Julio) e Rossi, "Rapport présenté, etc.," Turin, 1802, or "Transunto del Rapporto, etc.," Milano, 1803 ("Opusc. Scelti," vol. XXII., p. 51), translated into English, London, 1803 (*Phil. Mag.*, vol. XV., p. 38); also Vassalli-Eandi, F. Rossi et N. Michelotti, "Précis de nouvelles expériences galvaniques," Turin, 1809 ("Mém. de Turin," Années 1805–1808, p. 160). See, likewise, S. Berutti, "Elogio, etc.," 1839; "Saggio sulla vita . . . Vassalli-Eandi," Torino, 1825; "Notizie biografiche . . . Vassallie Eandi ("Mém. di Torino," vol. XXX., p. xix.); "Elogio, scritto dal Berrutti," ("Mem. of the Ital. Soc.," vol. XXII., p. liv.); *Phil. Mag.*, vol. XV., p. 319; *Journal de Physique*, An. VII., p. 336 and vols. XLIX., L.; "Ital. Soc. Mem.," vol. VIII., p. 516, X., p. 802; XIII., p. 85; XVII., p. 230; XIX., p. 347; "Mémoires de Turin," vols. X. to XIII.; "Mem. dell' Acad. di Torino," vols. VI., X., XXII., XXIV., XXVI., XXVII., XXIX.; "Mem. della Soc. Agrar. di Torino," vol. I.; "Opuscoli Scelti," vols. XIX., pp. 215, etc.; XXII., p. 76; "Nuova Scelta d'Opuscoli," vol. I., p. 167; "Opuscoli Scelti di Milano," quarto, vol. XIV.; "Mem. Soc. Ital.," vols. IV., p. 263; X., p. 733; "Biblioteca Oltremontana;" Brugnatelli's *Annali di Chimica;* "Giornale Scientifico . . . di Torino," vols. I., III.; "Giornale Fis. Med.," vol. II., p. 110; "Biblioteca Italiana"—"Bibliothèque Italienne," vols. I., p. 128; II., p. 25; "Recueil périodique . . . de Sédillot," vol. II., p. 266.

A. D. 1790–1800.——Morozzo—in Latin, Morotius—(Carlo Luigi, Comte), Italian savant, who studied mathematics under Lagrange, and was President of the Turin Academy of Sciences, publishes numerous scientific memoirs in French through the reports of the last named institution, in one of which he is said to have described an experiment suggesting the electromagnet.

See his biography in Larousse, "Dictionnaire Universel," tome XI., p. 577, and in the "Biographie Générale," tome XXXVI., p. 643.

A. D. 1791.——Leslie (Sir John), an able English scientist, professor of natural philosophy in the University of Edinburgh, writes a very interesting paper entitled "Observations on Electric Theories," which is read the following year, at the meeting of the Royal Society of Edinburgh, and is published at the latter place during 1824.

See A. D. 1751 at Adanson, "Encyclopedia Britannica,"

* Continued from The Electrical World of Dec. 26, 1891.

ninth edition, vol. XIV., p. 476; Dove, p. 256; *Philosophical Magazine*, vols. XL. and XLII.

A. D. 1791.——At p. 353, chap. 3, of the first volume of Gmelin's "Handbook of Chemistry," it is stated that during 1791, J. Keir–Kier first showed by immersing iron in a solution of nitrate of silver or fuming nitric acid, that many metals can be made to pass from their ordinary *active* state into a *passive* or electro-negative state and lose either wholly or for the most part their tendency to decompose acids and metallic oxides.

At pp. 167–170, Sixth Memoir, of Wm. Sturgeon's "Scientific Researches" (Bury, 1850), treating of the application of electric chemistry to the dissolution of simple metals in fluids, reference is made to the long line of investigations carried on by both Bergman and Keir, the last named having demonstrated that iron "acquires that *altered* state by the action of nitric acid which Sir John Herschel met with in his experiments, and has called *prepared* state, and that Schönbein and others call the *peculiar* or the *inactive* state" (see Noad's "Manual of Electricity," London, 1859, p. 534). The iron which is active in nitric acid Keir called "fresh iron," while that which became inactive, he called "altered iron" (Sturgeon's "Annals of Electricity," vol. V., p. 439).

Some remarkable phenomena in the display of which but one individual piece of metal is used, as first shown by Keir, remain, Sturgeon says, "without even an *attempt* at explanation by any of the philosophers under whose notice they have appeared." Sir John Herschel pronounces them as of an "extraordinary character:" Professor Andrews, after giving some very satisfactory explanations of several phenomena, acknowledges that he "can offer no explanation of most of the particular facts which have been described," and Professor Schöenbein has not yet made public any explanation of them whatever." *Phil. Mag.* for October, 1837, page 333, and for April, 1838, page 311.

See *Annalee de chimie* for October, 1837; *Phil. Trans.* for 1790, page 353, as well as Hutton's abridgment of the same, vol. XVI., page 694, and Sturgeon's "Annals of Electricity," vol. V., page 427; Gmelin's Chemistry, pages 367, 370.

## Magnetic Leakage in Dynamos and Motors.*

BY ARTHUR STANLEY IVES.

It is a well known fact that all of the lines of force generated in the field magnets, in almost if not quite all machines of the present day (and still more is it true of those of the past), do not accomplish the purpose for which they are produced, namely, pass through the core of the armature. This is partly due to the fact that the magnetizing coils are not evenly distributed all around the magnetic circuit; but is mainly, of course, because in all cases and of necessity there must be at least two gaps in the magnetic circuit—between the armature and the faces of the pole pieces—in order to give clearance for rotation. To illustrate, if a soft iron ring be wound with insulated copper wire, the latter being put in circuit with a battery, a magnetic current will be produced which will give no external evidence of its existence. There are no poles, and no lines of force can be seen when iron filings are sprinkled on a cardboard above it; yet inside the mass of the ring there is a strong magnetic field, for a secondary wire will have an electromotive force generated in it if the primary circuit be made or broken, the same as if a straight magnetic bar of iron had been inserted or withdrawn mechanically. If, however, the iron ring be cut in any place, poles and lines of force immediately appear externally, and the iron filings when sprinkled on the cardboard form themselves about as shown in Fig. 1.

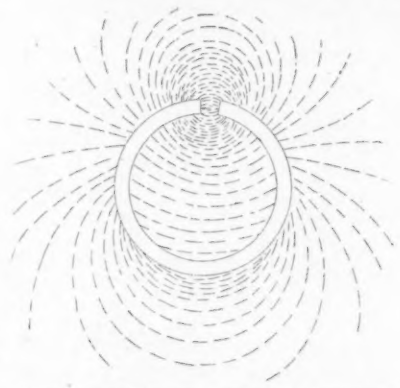


FIG. 1.—FIELD OF FORCE ABOUT A DISCONTINUOUS IRON RING.

We see, therefore, that even one air gap in a magnetic circuit will cause considerable leakage of magnetism into the surrounding medium.

In the case of dynamo field-magnets the magnetism so escaping implies a waste of current energy required to produce it, and its value is generally quite appreciable in reducing the efficiency of the machine.

It is on this account, perhaps, as much as any other, that so much attention has of late been given to the form of the magnetic circuit, although very few direct investigations have been made regarding the distribution of the magnetism in dynamos and motors since those of Dr. Hopkinson in 1886, which is somewhat remarkable considering the value they would be to designers of these machines.

*Graduation thesis in the Electrical Engineering course at Columbia College, 1891.

Of course measurements of magnetism (in electromagnets at least) are most conveniently made, both absolutely and relatively, by means of secondary induction currents, produced by making or breaking the primary field circuit. Hence the problem becomes one of a measurement of "instantaneous," or more properly, "transient" currents, or electromotive forces, and nothing more. These induced currents are not really instantaneous on account of the self-induction of the field magnet coils, which prevents the field current from attaining its full value at once, and also in large machines the magnetism itself seems to be sluggish in following the magnetizing current. Further, it takes an appreciable time for the induced current in the "test coil" to die away. For example, in testing the 400-light Edison machine it was noted that the induction lasted eight or ten seconds after making the field circuit.

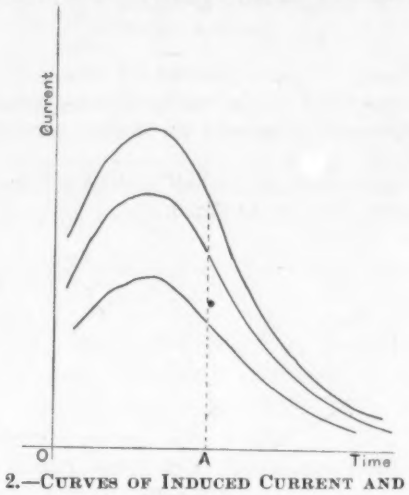



FIG. 2.—CURVES OF INDUCED CURRENT AND TIME.

It would seem therefore that a ballistic galvanometer, or one which would integrate over the whole time during which the induced current lasts, would be required for any accurate determinations, and such a one was, as a matter of fact, used by Dr. Hopkinson in his experiments. It is not, however, always easy to obtain a galvanometer which is sufficiently ballistic, nor when obtained to find a suitable place to mount it which shall be convenient to the machine to be tested, and, therefore, any other instrument which is at the same time accurate and portable is to be preferred.

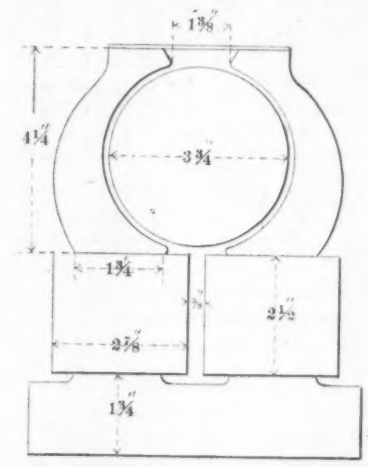



FIG. 3.—VERTICAL CROSS-SECTION OF CROCKER-WHEELER MOTOR.

The use of a Weston voltmeter (as the most accurate and portable instrument for the measurement of *ordinary* electromotive forces) suggested itself, and a number of preliminary tests were made to ascertain whether such a use would give the desired results. These tests were of a conclusive nature, and were highly satisfactory in every respect.

It might be considered, at first thought, that the "dead-beat" character of the instrument, as directly opposed to the accepted "ballistic" method, would be incompatible with the production of proportional deflections by means of currents of the nature considered. I hope at some future time to show, mathematically, that such a result is, however, in perfect accord with theory. For the present it is sufficient to say that for the same machine and the same magnetization, it will be readily seen that the same retarding elements exist—having the same value and acting in the same way and during the same time—and, therefore, at any given instant the value of the current in the test coil will be exactly proportionate to the total number of lines of force which will pass through it, and the curves of induced current and time will be as shown in Fig. 2. Hence, whether we use an instrument which will integrate the whole induction, or one which will integrate only a part of it (up to the time *OA*, for example), or one which gives simply the instantaneous value of the current at each instant, the amounts neglected will be proportional; and therefore the deflections will also be proportional to the total induction in each case, at least when the deflections are small. In the Weston meters, however, the proportionality holds true for any value of the angle deflected—as can be readily shown from the theory of the instrument—a decided advantage over the ballistic galvanometer, whose deflections are only directly proportional if they are small.

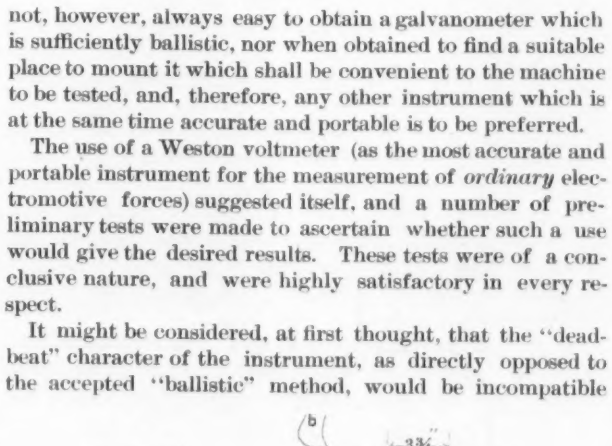



FIG. 4.—DIMENSIONS OF CROCKER-WHEELER ONE-SIXTH HORSE-POWER MOTOR.

The practical confirmation (referred to above) of this theory, namely, that the deflections of the voltmeter are directly proportional to the number of lines of force created or destroyed, multiplied by the number of turns of wire in the test coil surrounding them, was obtained by winding in succession a different number of turns of wire around the same part of one of the field magnets of a 3-h. p. Crocker-Wheeler motor, and the deflections of the voltmeter noted on "breaking" the field circuit. The armature had been disconnected, and the poles of the field connected directly with a constant potential circuit of about 120 volts. The ends of the test coil were attached directly to the voltmeter. The results were as follows:

TABLE I.

| Number of turns. | Mean deflection (of 5 observations). | Deflection (per turn). |
|---|---|---|
| 3 | 50.3 | 16.77 |
| 6 | 99.9 | 16.65 |
| 9 | 149.2 | 16.58 |
| 12 | 198.2 | 16.52 |
| 15 | 247.4 | 16.49 |
| 18 | 296.7 | 16.48 |
| 21 | 346.6 | 16.51 |
| 24 | 395.5 | 16.48 |

Mean = 16.56; or mean, omitting first two observations, = 16.51. The scale on which these readings were taken could not be read directly to less than four units, so each unit equals a quarter of one division. Single observations were read to half units or eighth divisions.

The variation of the smaller deflections from the rest is no doubt due simply to the fact that they are small, the same error in observing being a larger percentage of the reading than in the case of larger deflections.

It was also observed at another time, and with a different machine, that for low magnetizations (where the magnetism is proportional to the field current in direct ratio), the deflection produced in the voltmeter with the same number of turns in the secondary is exactly proportional to the current sent through the field, the results differing only about one-tenth of one per cent.

Hence we may safely assume that errors of observation are as great or greater than any instrumental discrepancies in proportionality; and, on this assumption, the method becomes a practical one, with the advantage of using an instrument which requires no adjustments, and which is not disturbed by ordinary magnetic changes in its neighborhood.

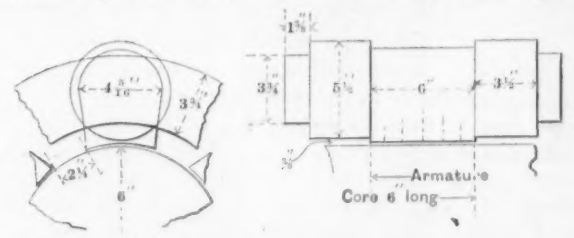



FIG. 5.—SINGLE POLE AND ADJACENT COILS OF STANDARD DYNAMO.

The following machines have been tested (employing this method):

I. ⅙-h. p. Crocker-Wheeler motor.

II. 3-h. p. Crocker-Wheeler motor.

III. 400-light (117 volts—200 ampères) standard (multipolar) dynamo.

IV. 100-light (1,000 volts—8 ampères) Fort Wayne alternator.

V. 400-light (117 volts—200 ampères) Edison dynamo.

In each machine a certain number of turns of wire were wound around the various parts named, except for determining the leakage directly, in which case the coils were held against the surface from which it was thought to take place. In every case (including the preliminary experiments) the deflections were observed on *breaking* the primary field circuit, because its maximum value was found to be about double that of the *make* induced current (as would have been expected from theory—see Fleming on the "Alternate Current Transformer," vol. I., p. 191), and its duration was not as long either. The instrument used was the calibrating coil (137.7 legal ohms resistance) of Weston voltmeter No. 290,—600 volt scale, one division equals four volts,—that being the most delicate instrument of the type available. No. 26 wire, double covered, B. & S. gauge, was used throughout for the test coil.

The tests on all machines were made with their fields magnetized to their regular working strength; that is to say, the current sent through the field coils was that for which they were designed. The armatures, however, were carrying no current and were stationary.

I.—ONE-SIXTH H. P. CROCKER-WHEELER MOTOR.

A vertical cross-section of this machine is given in Fig. 3, with all important dimensions.

As these were the first measurements made they are probably less accurate (on that account) than those taken on the other machines:

TABLE II.

| Position of coil. | Number of turns. | Mean deflection. | Deflection per turn. | Percentage of max. |
|---|---|---|---|---|
| Middle of field coil | 10 | 15 | 1.50 | 100. |
| Base of pole piece | 12 | 15 | 1.25 | 83.3 |
| Middle of pole piece | 13 | 8 | .62 | 41.3 |
| Armature | 14 | 15 | 1.07 | 71.3 |
| Leakage between points of poles (upper) | 24 | 0.5 | .02 | 1.3 |

In this machine therefore we ha ve a total loss of 28.7 per cent., of which 16.7 per cent. leaks from the upper half of the field coil, and 12 per cent. from the surface of the pole-piece.

We see also that due to leakage from the lower half of pole piece, a little less than one-half the magnetism that enters its base passes through its middle section.

We require 140 per cent. of the effective magnetism to be generated by the field.

II.—3-H. P. CROCKER-WHEELER MOTOR.

Fig. 4 shows the general dimensions of this motor as well as the "lettered" positions of the test coil.

The following measurements were taken on this machine:

TABLE III.

| Position of coil. | Number of turns. | Mean (of 10) deflections. | Deflection per turn. | Percentage of max. |
|---|---|---|---|---|
| Middle of field coil | 15 | 246.50 | 16.433 | 100. |
| Yoke end " " | 15 | 244.65 | 16.310 | 99.2 |
| Pole " " " | 15 | 236.95 | 15.797 | 96.1 |
| (a) | 15 | 235.55 | 15.703 | 95.6 |
| (g) | 75 | 3.75 | 0.050 | 0.3 |
| Base of pole piece | 15 | 231.45 | 15.430 | 93.9 |
| (d) | 75 | 19.95 | 0.266 | 1.6 |
| (e) | 75 | 27.75 | 0.370 | 2.3 |
| (f) | 75 | 19.45 | 0.258 | 1.6 |
| Middle of pole piece | 30 | 227.35 | 7.578 | 46.2 |
| (b) | 75 | 16.05 | 0.214 | 1.3 |
| (c) (each side) | 75 | 15.80 | 0.201 | 1.2 |
| Top of pole piece | 75 | 33.45 | 0.446 | 2.7 |
| Armature | 18 | 244.45 | 13.581 | 82.6 |
| Between upper horns of pole pieces | 75 | 6.50 | 0.087 | 0.5 |

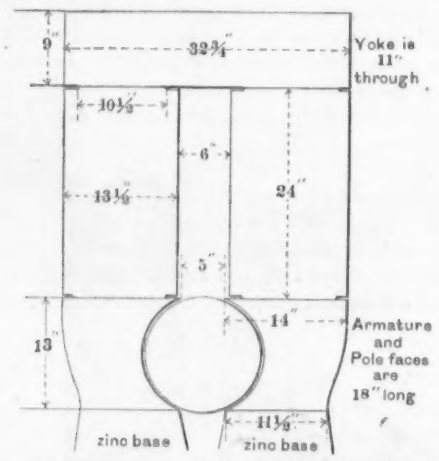



FIG. 8.—DETAILS OF 400-LIGHT EDISON DYNAMO.

The following conclusions are apparent:

1. The discrepancy in observations is very small.

Leakage from upper half of coil = 4.2 per cent.
Leakage from pole piece:
Back = 2.9
Sides = 4.3
Top = 3.2
Total leakage found directly = 16.6 per cent.
Total loss (found by subtracting armature from maximum) = 17.4
Unaccounted for = 0.8 per cent.

2. There is practically no leakage from the lower half of coil (only 0.8 per cent.); and only 4 or 5 per cent. from the base of the machine which acts as the yoke (not in Table III., but actually obtained. It was found also by winding 50 turns around shaft and bearings nearest armature, that the leakage in that direction is only about $\frac{1}{10}$ of 1 per cent.).

3. As in the ⅛-h. p. motor, and for the same reason, we have slightly less than one-half the magnetism entering the base of the pole piece passing through its middle section.

4. We require 121 per cent. of the effective magnetism to be generated by the field.

III.—400-LIGHT STANDARD DYNAMO.

A single pole with its adjacent coils is shown in Fig. 5.

The measurements taken on this machine were as follows:

TABLE IV.

| Position of coil. | Number of turns. | Mean (of 10) deflections. | Deflection per turn. | Percentage of maximum |
|---|---|---|---|---|
| Middle of field coil | 15 | 233.5 | 15.567 | 100. |
| Yoke end | 15 | 233.0 | 15.553 | 99.8 |
| Yoke | 18 | 245.7 | 13.650 | 87.7 |
| Pole end of field coil | 15 | 217.2 | 14.480 | 93.0 |
| Armature | 20 | 236.0 | 11.800 | 75.8 |
| Back of pole piece | 75 | 52.3 | 0.697 | 4.5 |
| Each side | 75 | 73.8 | 0.984 | 6.3 |
| Leakage found f'm inside half of coil. | 75 | 70.3 | 0.937 | 6.0 |

Conclusions:

1. Leakage from half coil = 6.0
" " pole piece:
Back = 4.5
Sides = 12.6 = 17.1
Total leakage found directly = 23.1 p. c.
Loss (by subtraction) from half coil = 7.0
" " " pole piece = 17.2
Total loss (substracting armature from maximum = 24.2
Unaccounted for = 1.1 p. c.

2. Only 87.7 per cent. of the magnetism passes through the yoke, though practically no leakage takes place from the half coil.

3. The leakage from the half coil nearer the pole piece is distributed about as in Fig. 6.

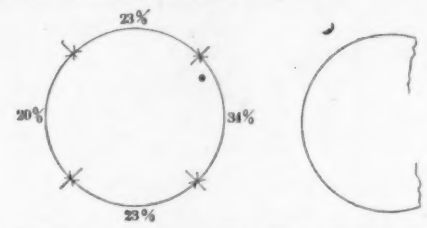



FIG. 9.—LEAKAGE ABOUT THE POLE PIECE IN EDISON DYNAMO.

4. We require 132 per cent. of the effective magnetism to be generated by the field.

IV.—100 LIGHT FORT WAYNE ALTERNATOR.

A single pole and coil are shown in Fig. 7.

In this case the following measurements were obtained:

TABLE V.

| Position of coil. | Number of turns. | Means (of 10) deflections. | Deflection per turn. | Percentage of maximum. |
|---|---|---|---|---|
| Yoke | 12 | 312.50 | 26.042 | 98.3 |
| Yoke end of field coil. | 10 | 264.90 | 26.490 | 100. |
| Middle of field coil. | 10 | 256.80 | 25.680 | 96 9 |
| Pole end of field coil. | 10 | 224.45 | 22.445 | 84.7 |
| Core (field) | 10 | 196.10 | 19.610 | 74.0 |
| Armature. | 10 | 190.80 | 19.080 | 72.0 |
| Total side leakage (each side) | 10 | 32.25 | 3.225 | 12.2 |
| Total end leakage (each side) | 75 | 27.00 | 0.360 | 1.4 |

Conclusions:

1. Leakage found:
Sides = 24.4 per cent.
Ends = 2.8
Total leakage observed directly = 27.2
Total loss (subtracting armature from maximum) = 28.0
Unaccounted for = 0.8 per cent.

2. It is curious to remark that in this machine the maximum magnetization is not at the middle of the field coil, as in all the other machines tested, but at the end nearer the yoke. This is probably due to the angle which the axis of the coil makes with that of either adjacent one.

3. The leakage from the yoke is very small indeed, only 1.7 per cent.

4. We require 139 per cent. of the effective magnetism to be produced by the field.

V.—400-LIGHT EDISON DYNAMO.

Fig. 8 will give a clear idea of the proportions and design of this machine.

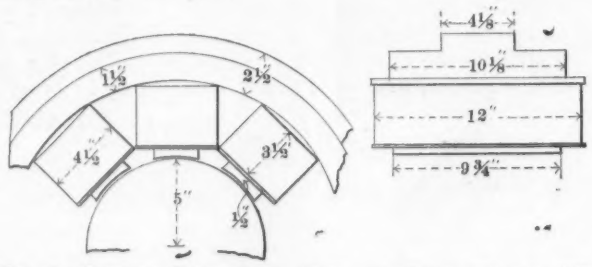



FIG. 7.—SINGLE POLE AND COIL OF FORT WAYNE 100-LIGHT ALTERNATOR.

The tests on this machine resulted as follows:

TABLE VI.

| Position of coil. | Number of turns. | Mean (of 20) deflections. | Deflection per turn. | Percentage of maximum. With normal field current. | Percentage of maximum. With ¾ of normal field current |
|---|---|---|---|---|---|
| Middle of field coil. | 5 | 319. | 63.80 | 100. | 100. |
| Yoke end of field coil. | 5 | 288.45 | 57.69 | 90.4 | 92.3 |
| Yoke | 6 | 304.70 | 50.78 | 79.6 | 82.8 |
| Pole end of field coil. | 5 | 265.45 | 53.09 | 83.2 | 86.8 |
| Armature | 6 | 229.50 | 38.25 | 60.0 | 63.7 |
| Outside ¼ of lower ½ coil | 25 | 47.50 | 1.90 | 3.0 | .... |
| Inside ¼ of lower ½ coil | 25 | 74.80 | 2.99 | 4.7 | .... |
| Front or back ¼ of lower ½ coil | 25 | 51.00 | 2.04 | 3.2 | .... |
| ½ back of pole piece | 25 | 52.20 | 2.09 | 3.3 | .... |
| Each side of pole piece | 25 | 55.40 | 2.22 | 3.5 | .... |
| Base of pole piece | 10 | 43.60 | 4.36 | 6.8 | .... |
| Across upper pole points | 25 | 13. | 0.52 | 0.8 | .... |
| End of yoke | 25 | 55.80 | 2.23 | 3.5 | .... |
| Top of yoke | 25 | 34.30 | 1.37 | 2.2 | .. |
| Each side of yoke | 25 | 29.80 | 1.19 | 1.9 | .... |

The figures in the last column are the final results of a partial set of observations taken with only about ¾ of the normal field current through the field coils.

With regard to this machine we observe as follows:

1. Leakage from lower half coil = 14.1
" " pole piece:
Back = 6.6
Sides = 7.0
Base = 6.8
Across points = 1.6 = 22.0
Total leakage found directly = 36.1
Loss (by subtraction) from half coil = 16.8
" " " " pole piece = 23.2
Total loss (subtracting armature from maximum) = 40.0
Unaccounted for = 3.9 p. c.

2. Leakage found from yoke:
End = 3.5
Top = 2.2
Sides = 3.8
Total found directly = 9.5
Loss from yoke (by subtraction) = 10.8
Unaccounted for = 1.3 p. c.

3. Total loss (by subtraction) from middle of field coil to middle of yoke = 20.4 per cent.

4. The leakage from the half coil nearer the pole piece is distributed around the circumference in about the ratio given by Fig. 9.

5. We require 166 per cent. of the effective magnetism to be produced by the field.

6. An increase of 33 per cent. in the field current gave only 3.7 per cent. more loss. This increase in current, however, only produced 21 per cent. increase in maximum magnetization, the smaller current giving a deflection of 52.56 per turn at the middle of the field coil.

7. The greater discrepancy in the results obtained for this machine (as compared with the others) is no doubt due principally to the difficulty found in making a clean break in the field circuit, the lever of the knife switch being short and the flash quite intense. Hence, to render this of as small account as possible, twenty readings were taken in each position of the coil to obtain a mean. The character of the reading could be readily told by simply observing the amount of flash on breaking the circuit; and vice versa, the intensity of the flash (or the cleanness of the break) could be as surely told by observing the variation of any single deflection from the mean. With this in

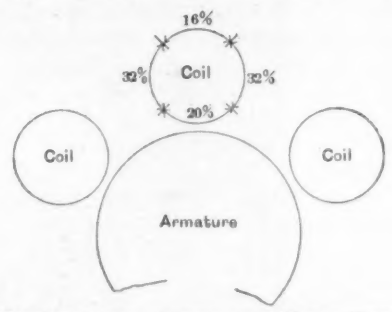



FIG. 6.—DISTRIBUTION ABOUT THE POLE PIECE IN THE STANDARD DYNAMO.

mind, it will be seen at once that we may with perfect confidence discard observations which are evidently inaccurate, or weight the others so as to accomplish the same result. If, selecting the simpler method, we retain from each set only those readings which have presumably been produced by a proper break, and take their mean, we shall obtain the following, instead of the results of Table VI.:

TABLE VII.

| Position of coil. | Percentage of maximum. | Position of coil. | Percentage of maximum. |
|---|---|---|---|
| Middle of field coil. | 100. | Leakage from back ¼ of lower ½ coil. | 3.3 |
| Yoke end of " | 90. | | |
| Yoke | 80.1 | | |
| Pole end of field coil | 85.1 | Leakage from back of pole piece | 6.6 |
| Armature | 61.1 | Leakage from (both) sides of pole piece | 7.2 |
| Leakage from outside ¼ of lower ½ coil. | 3.1 | Leakage from base of pole piece | 7.1 |
| Leakage from inside ¼ of lower ½ coil. | 4.9 | Leakage across (upper and lower) pole points | 1 8 |
| Leakage from front ¼ of lower ½ coil. | 3.3 | L kge at end of y'ke | 3.5 |
| | | L'kge at top of y'ke | 2.2 |
| | | L'kage from (both) sides of yoke | 3.8 |

Taking the sum of the leakage between middle of field coil and armature found directly, as given in Table VII., we find a total of 37.3 per cent., and total loss (subtracting armature from maximum) being 38.9 per cent., leaving unaccounted for 1.6 per cent., instead of 3.9 per cent. as before.

Again, the total leakage found from yoke end of field coil to middle of yoke equals 9.5 per cent, and total loss (subtracting yoke from yoke end of field coil) from Table VII. equals 9.9 per cent.; unaccounted for, 0.4 per cent.

These latter results are quite within the limits of observation, and from previous considerations are in all probability the most accurate.

SUMMARY.

The summary given in Table VIII. of the results obtained above may be convenient for comparison.

TABLE VIII.

| Machine. | From maximum to armature. Loss (by subtrac'n.) | From maximum to armature. Leakage f'nd di'ctly | Loss (by subtract'n) from maximum to yoke. | Ratio of maximum to effective magnetism. | Total current. | Field current. | Percent. of energy in field. | Percent. of energy lost in field due to leakage. |
|---|---|---|---|---|---|---|---|---|
| ½-h. p. Crocker-Wheeler motor | 28.7 | .... | .... | 1 40 | 2 | .25 | 12.5 | 3 5 |
| 3-h. p. Crocker-Wheeler motor | 17.4 | 16 6 | 5 (est.) | 1.21 | 24 | .38 | 1.6 | 0.3 |
| 400-light Standard dynamo | 24.2 | 23.1 | 12.3 | 1.32 | 220 | 10.6 | 4.8 | 1.2 |
| 100-light Fort Wayne alternator | 28.0 | 27 2 | 1.7 | 1.39 | .... | ..... | .... | .... |
| 400-light Edison dynamo (with ¾ of normal field current) | 36.3 | .... | 17.2 | 1.57 | .... | 5.2 | .... | .... |
| 400-light Edison dynamo (with normal field current), *mean values* | 40.0 | 36.1 | 20.4 | 1.67 | 220 | 7.2 | 3.3 | 1.3 |
| 400-light Edison dynamo (with normal field current), *preferable values* | 38.9 | 37.3 | 19.9 | 1.64 | 220 | 7.2 | 3.3 | 1.3 |

Of course the detailed search for the leakage (in addition to its determination by subtraction) is of value in locating its distribution more definitely, but its principal use is as a check to the other results.

The chief interest, however, in this investigation, from an economic standpoint at least, centres in the fifth column of Table VIII., which gives the amount of magnetism which must be produced by the ampère turns in the field in terms of the number of lines of force required to pass through the armature—which is nothing more nor less than the *leakage coefficient* ($\lambda$) of Hopkinson, which he uses in determining the ampère turns required for the field. A complete set of these values for all forms (and sizes) of field magnets would be perhaps as valuable an addition to dynamo data in hand as any that could be made, and this method of obtaining them seems to offer advantages superior to any heretofore used.

One effect of this leakage is given in the last column of the same table, namely the decrease in the running efficiency of the machines due to the fact that extra current energy is of course consumed by the field. It must not be supposed, however, that this waste of energy is the only or even the most injurious result of magnetic leakage, for there are at least three others.

1. It will be seen at once that if only 75 per cent. of the magnetism produced by the field passes through the armature, there will be a considerable amount of iron and wire in the field which is employed to no purpose; in other words, there will be waste material in the field with all its attendant disadvantages.

2. Since the lost magnetism becomes scattering lines of force in the neighboring air, we know that watches and electro-magnetic instruments of all kinds in the vicinity will be affected thereby.

3. Those lines leaking from the points (or horns) of the pole pieces are liable to enter the armature at the neutral space, and so cause sparking.

This question of leakage, then, from more than one standpoint, is a most important one, and well deserving of careful attention and investigation.

It has been suggested that an error is introduced by the fact that no account is or can be taken of the residual magnetism in the circuit, and that all the lines of force are not withdrawn when the primary circuit is broken. It will, however, be evident on second thought that the residual magnetism is no different from any other, and forms a closed circuit through the iron in the same way, so that it is probable that the distribution in all parts is proportional or very nearly so, as the residual is in the smaller machines not over 1 or 2 per cent., and in the Edison not over 4 per cent. of the normal magnetization, and we have seen that an increase of 21 per cent. in the magnetization of the Edison only produced an increase in per cent. lost of 2.6 per cent. (taking the more probable values). So a maximum error of ½ of 1 per cent. may perhaps be laid to residual magnetism, but no more, and that is for our purposes negligible.

To conclude, since no one doubts the accuracy of the ballistic method, as a final check on the accuracy of the method proposed, two or three sets of readings were taken with a galvanometer having a time of vibration of nearly 12 seconds, and a logarithmic decrement of less than 0.01, on the 3-h. p. Crocker-Wheeler motor with the following results:

TABLE IX.

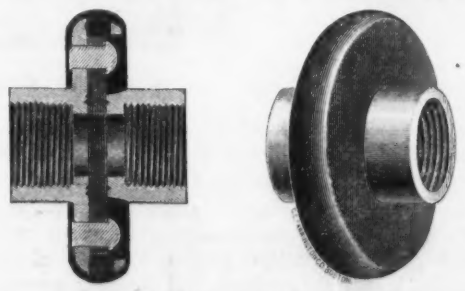
| Position of coil. | Percentage of maximum, voltmeter method. | Percentage of maximum, ballistic method. |
|---|---|---|
| Middle of field coil | 100. | 100. |
| Pole end of " | 96.1 | 96.1 |
| Armature | 82.6 | 82.7 |

Column 2 is taken from Table III.

This is a most remarkable and highly satisfactory agreement.

## Solid Mica Insulating Joint.

The W. T. C. Macallen Company, 161 High street, Boston, is manufacturing a solid mica insulating joint for combination gas and electric fixtures, which, for simplicity, thorough workmanship and insulating qualities, is said to be one of the best insulating joints on the market. The insulation is composed of thin strips of mica tightly compressed between the upper and lower ends of the joint, the whole being riveted together, thus forming a very strong and compact connection. The joint is then covered entirely with an insulating compound, which prevents creeping of moisture or contact of bare wires. As will be seen from the cut, the joint presents a very neat appearance.



MICA INSULATING JOINT.

This joint may be heated to apply cement in making connections without the slightest injury to the insulation, which recommends it to those putting in work where these insulators are used. The company has a well equipped factory and is prepared to make anything in the line of mica specialties.

## The Waddell-Entz Dynamo.

An ingenious type of dynamo has recently been developed by the Waddell-Entz Electric Company, of this city, two views of which are shown herewith.

This machine has a capacity of 3. h. p. The motor is of the Gramme ring type with internal poles, and runs at 1,100 revolutions per minute. The variation in speed between no load and full load is less than two per cent. Being a plain shunt machine, this is accomplished without any series or differential winding of the field, which has the drawback of reversing the field when starting the motor across a line, and causing the machine to run first backward and then forward. By a proper proportioning of the field and armature reactions, the weakening effect of the armature on the poles is just sufficient to compensate for the loss in speed that would result from a drop in the armature and other causes. There is no sparking at the brushes for any variation in load, and very little heat of the armature and magnet coils when running at its full load.

The armature is entirely inclosed in a brass shield, no wires being visible on the armature. This shield serves to protect the armature from injury, and gives the machine a very attractive appearance.

The magnetic circuit of the machine is composed of two castings of cast steel or malleable iron with a bushing through the centre of the magnet core for the shaft bearing, thus giving one long bearing with the armature overhung at one end and the pulley at the other.

The machine work on the magnet is extremely simple; all boring and turning being on one centre, but one setting and centring in the mill is necessary. There is no planing work on the machine excepting the rails. The magnet coil is wound separately on an iron spool, and is slipped on the core of the magnet, which is cast to the right diameter and requires no turning off.

The form of the magnetic circuit cannot be readily seen from the cut. It is a single core wound with the magnet coil and pole pieces, brought from each end of the core around the head and top of the coil and presented to the inside armature surface. This gives a magnetic circuit as short as possible, and is economical both as regards weight of metal and the exciting power required.

The machine is self-oiling, and has an oil reservoir and chain at each end of the shaft. The oil wells communicate with each other by a hole at the bottom of the core, and are filled from the back end of the machine, where the drain pipe is also situated. These oil wells and holes are all cored out in the casting and represent no machine work. The bed plate is a casting of ordinary gray iron and has a saddle at the back, being bored out to fit the magnet, which is bolted to it. The seat for the brush holder frame is bored out at the same centring.

The weight of the machine complete is 316 pounds. The over-all dimensions are: Height, 18 inches; length, with pulley, 18 3-16 inches; width over rails, 19 inches. The machine being practically a cube in its dimensions occupies the smallest possible space for a given weight of material. The commercial efficiency of this machine is said to be 86 per cent. on full load.

Larger machines of this kind are of the multipolar type, but with a single core and exciting coil, as in the present size. This construction makes it possible to build as efficient a multipolar machine as a bi-polar, which it is claimed is not possible with the multiple core and coil type.

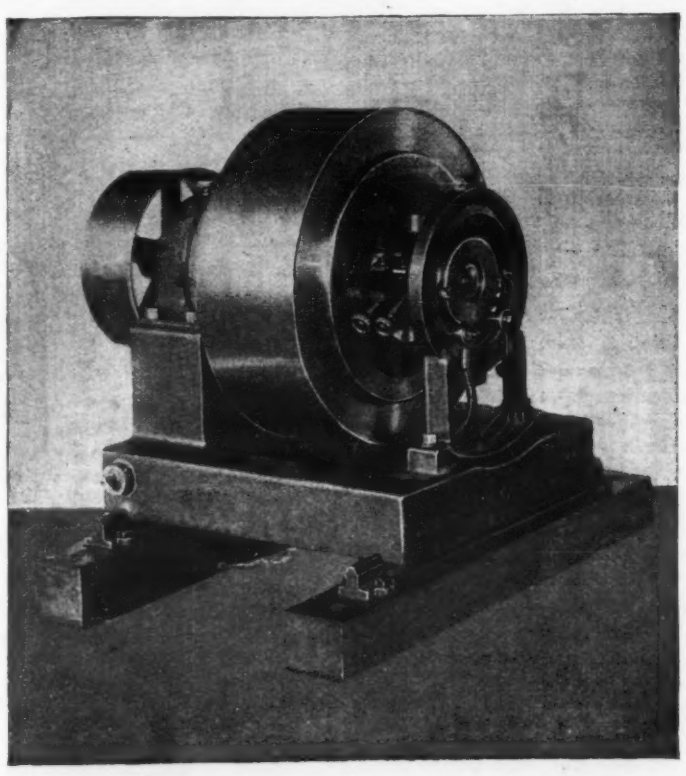


FIG. 1.—WADDELL-ENTZ DYNAMO.

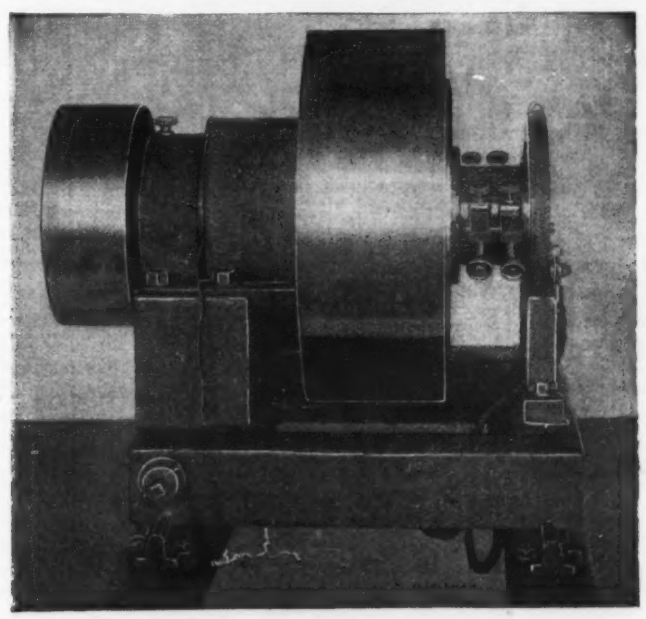


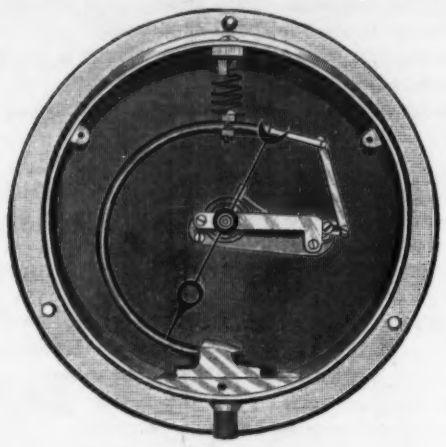
FIG. 2.—WADDELL-ENTZ DYNAMO.

## The New York Electrical Society.

The next meeting of the New York Electrical Society was announced early in the week. The programme specified a lecture by Mr. A. A. Knudson on "Frauds in the Electrical Business," dealing with the various ways in which the general belief of the public is taken advantage of by cranks.

### The Boston Patent Steam Gauge.

The Boston Steam Gauge Company, 28 Beech street, Boston, is manufacturing a new and improved pressure gauge for steam or water, which is meeting with great favor among engineers and steam users generally. Among the points to recommend it are its non-freezing and non-setting qualities. The latter will be readily appreciated by engineers, as experience has shown that in the ordinary gauge, owing to the tube becoming set by constant expansion, the indicating hand fails to come back to the pin, being in many cases from five to ten pounds off. With the Boston patent gauge this difficulty is obviated, there being, as will be seen in the cut, a hardened steel spring attached to the top of the case and the brass tube, so that "setting"



Boston Steam Gauge.

is absolutely impossible. Those who have used these gauges speak in the highest praise of their excellent working qualities.

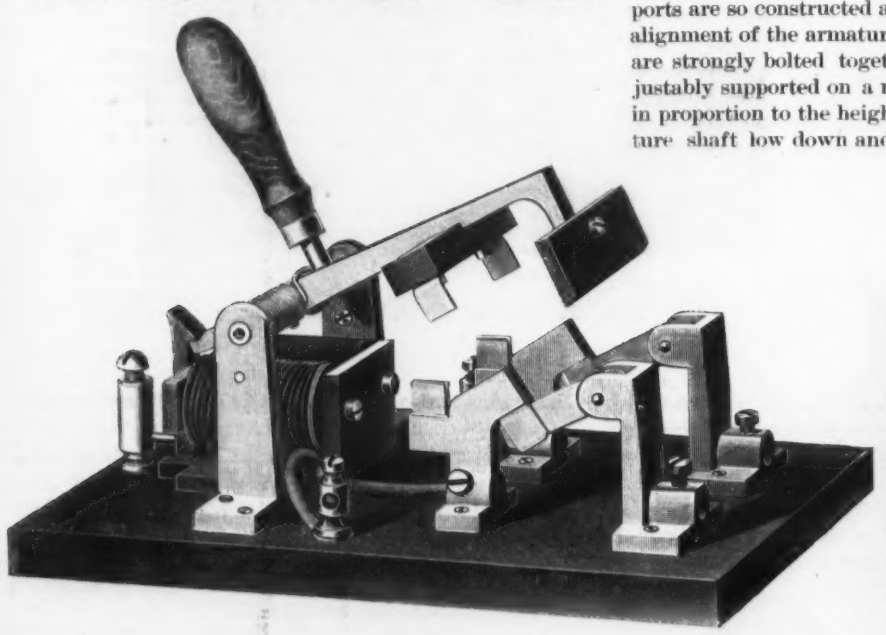
### Switch for Charging Storage Batteries from Arc Circuits.

An ingenious switch, a view of which is given in the accompanying illustration, has been devised for charging storage batteries from arc lighting circuits without opening or interrupting the circuit. It is the invention of Mr. W. S. Hill, of Boston, Mass.

The switch has four contacts, an electromagnet, and a lever actuated by a spring. When the lever is raised, as shown in the cut, the magnet, the four contacts and the batteries to be charged are all connected in series between the two binding posts. The latch that holds the lever up is held by the pull of the magnet on an armature. Should anything occur to open the circuit for an instant, the magnet will be demagnetized and the latch be drawn back by a spring, releasing the lever which will then drop and close the circuit between the two main line contacts, restoring the circuit. At the same time the connection between the main and the battery contacts is broken, thereby disconnecting both ends of the battery circuit and preventing its being short circuited on itself.

With slight modification, the same device is used to cut out the batteries when they have been sufficiently charged.

In this case the position of the magnet is reversed and it is made to release the latch, when a predetermined amount of current is passing through the magnet, the circuit through the magnet being connected in shunt to the terminals of the batteries.



HILL STORAGE BATTERY SWITCH.

These switches are manufactured by the W. S. Hill Electric Company, of 54 Devonshire street, Boston, Mass.

### Dow Lamp Adjustment.

We give herewith a cut of the Dow patent adjustment for incandescent lamps, a device that is at once simple, substantial and ornamental.

The case enclosing spring and extra cord is made of metal, either gilt, nickel or bronze finish. The spring works on the same principle as a curtain fixture, and the lamp is raised or lowered after the same fashion. The mechanism is simple in the extreme, and the low figure at which it is sold brings it within the reach of all. This is

Dow Lamp Adjuster.

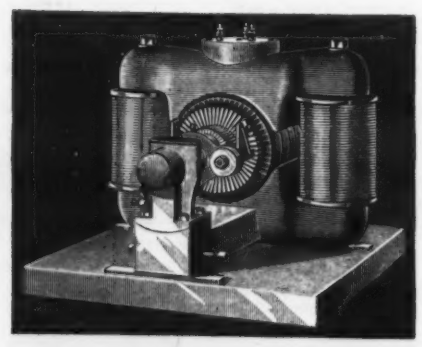
being manufactured by the Dow Adjustable Light Company, 309 Washington street, Boston.

### "Niagara" Dynamos and Motors

A new-comer into the electrical field is the Lovell Manufacturing Company, Limited, of Erie, Pa., which is offering a dynamo of excellent design, as will be seen from the illustration. It can be used, as might be expected, either as a dynamo or motor. In mechanical detail the parts are few, simple, large and strong in proportion to the work to be performed. Journal boxes are self-aligning, and provided with large self-oiling wells. The journal box supports are so constructed as to insure perfect and permanent alignment of the armature with the pole pieces. All parts are strongly bolted together, and the entire machine adjustably supported on a metallic base, the base being large in proportion to the height of the machine, and the armature shaft low down and centrally located as to the mass of the machine, preventing any tendency toward vibration.

The pole pieces are of soft cast iron, and the field cores of soft wrought iron, having large contact surfaces between them. The field coils are located close to the armature, forming a short, evenly balanced and powerful magnetic field. The armature is of the Gramme type, with important modifications which prevent Foucault currents and insure good ventilation and low electrical resistance. Sparking is entirely avoided, and the armature may be reversed without changing the commutator brushes, a valuable feature in many cases, such as running elevators or hoists with direct connection. With the "Niagara" this may be done without a rheostat.

The commutator is large in diameter, having a large number of segments which are made of pure homogeneous hard cast durable copper.



NIAGARA DYNAMO.

The brush holders are permanently fixed on a horizontal plane. The brushes are held in sockets and are pressed by a large spring against the commutator, insuring good contact with almost imperceptible wear, while the brushes are readily removed for inspection or cleaning.

### A New Flexible Conduit.

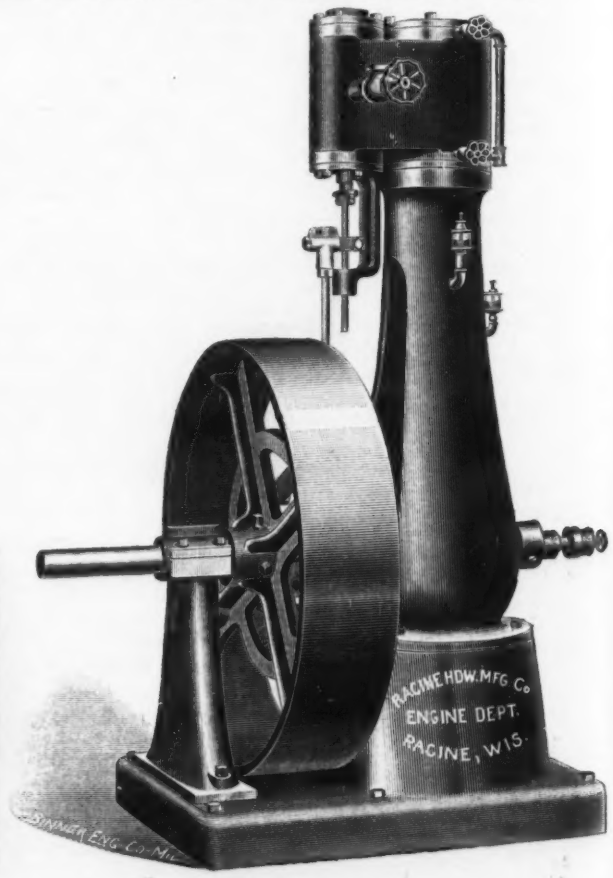
The American Circular Loom Company, of Boston, are placing on the market a new flexible conduit, the invention of Mr. Chas. H. Herrick, of that city. The tube consists of a spiral of linen fibre, especially made for this purpose, over which a covering of fine Para tape is laid, the whole being then covered with the celebrated "Canvas Jacket" weaving of the American Circular Loom Company. As the covering is woven, not braided, it is particularly adapted for this purpose, preventing entirely the elongation of the tube, which would occur were the outer covering braided or knit. It is made in 100-foot lengths.

Flexible Conduit.

One of the tests made with this tubing was an immersion in water for 5,000 hours continuously, without developing the least sign of moisture on the inside of the tube. This was demonstrated by the insertion in the tube, during the test, of single wound cotton magnet wire, connected with 16 c. p. incandescent lamps. The water in which the tubing was immersed was also repeatedly heated to 140 degrees F. and again cooled, showing it proof against any reasonable heat that would occur in actual practice. This tubing will be found valuable for running wires across faces of iron and stone buildings, back of signs, etc. It is especially strong in tensile strength, while its resistance to crushing strains is remarkable. The covering acts as a cushion to diminish the effects of blows or strains.

### The Racine Improved Automatic Engine.

There would appear to be but little room for another high speed automatic engine, but the Racine Hardware Manufacturing Company, Racine, Wis., has succeeded in bringing out and firmly establishing on the market a neat and compactly built vertical engine. The accompanying cut shows one of their 15-h. p. engines. The floor space of the base is but 24 × 36 inches, while it carries a 34-inch governor pulley.




RACINE ENGINE.

The steel crank shaft has two wide bearings on the frame of the engine, and in addition a heavy outbearing beyond which it extends far enough to permit a pulley of any desired size to be used. On the short end of the engine shaft is arranged the compression grease cup for oiling crank pin brasses. This cup can be detached, filled and again placed in position while the engine is running. This enables the engine to make long continuous runs, as a "wiper" is arranged for lubricating the brasses on the cross-head end of

the connecting rod. The governor is accurately balanced when running at any speed, thus insuring perfect control at all times. By the adjustment of weights and springs, it can be set for a wide range of speed.

The company has four of these engines in use in different parts of its extensive establishment, as it is found to be economical and convenient to pipe steam rather than convey power by any other means.

Though it numbers among its regular customers such firms as the Edison General Electric Co. and a half dozen other electrical firms, still a large portion of its trade comes from establishments desiring to subdivide their power, instead of having it massed in one large engine. One of these engines is running a large plant in Chicago from Monday morning until Saturday night without stopping. There is a demand for these engines from Maine to California. Recent orders include shipments to Texas, Montana, Maine, Oregon, Delaware, Georgia, Kansas, Ohio, Louisiana, Tennessee, Pennsylvania, besides numerous orders from points in Wisconsin and neighboring States. The manufacturers have recently added several thousand dollars worth of special tools to the equipment of their engine department, and are usually able to make immediate shipment from their stock. The engine is built in sizes ranging from cylinders three inches in diameter to thirteen inches diameter.

They report trade for 1891 as being more than three times the volume of last year's business, and regard the outlook as particularly bright.

# Financial Intelligence.

## THE ELECTRICAL STOCK MARKET.

**Chicago Quotations.**—Col. S. G. Lynch, broker, 153 Monroe street, Chicago, furnishes quotations on electrical stocks as follows:

TELEPHONE STOCKS.

| | | | | | |
|---|---|---|---|---|---|
| Chicago | $224@ | $226 | Cumberland | $60@ | $62 |
| Central Union | 52@ | 53 | Wisconsin | 118@ | 120 |
| Michigan | 81@ | 83 | Bell of Missouri | 175@ | 180 |
| Great Southern | 30@ | 32 | Missouri & Kansas | 54@ | 56 |
| Colorado | 34@ | 36 | Iowa Union | 20@ | 22 |
| Rocky Mountain Bell. | 40@ | 43 | | | |

ELECTRICAL STOCKS.

| | | | |
|---|---|---|---|
| Chicago Arc Light and Power | $81@ | $82 | Chicago Edison Co. $139@$140 |

## NEW INCORPORATIONS.

**The Colchester Electric Light and Power Company** of Colchester, Ill., capital stock $6,000, has been formed to furnish electricity for fuel, lighting and power. S. D. Mills, Jno. E. Hall and M. P. Agnew are the promoters.

**The Everett Light and Power Company,** of Everett, Wash., with a capital stock of $50,000, has been formed to furnish electric light and power. Henry Hewitt, Jr., and J. H. Brownell, of Tacoma, Wash, are interested in it.

**The Neversink Light, Heat and Power Company,** of Reading, Pa., with a capital stock of $50,000, has been organized to supply light, heat and power. George Brooke, R. T. Leaf and Henry T. Kendall are those engaged in this new enterprise.

**The Hornellsville Electric Railway Company,** of Hornellsville, N. Y., capital stock $50,000, has been incorporated to operate a street surface railroad. Berton McConnell, E. F. Wellets and John Adsit, all of Hornellsville, N. Y., are interested therein.

**The Mexican Chemical-Electric Company,** of Chicago, Ill., with a capital stock of $2,000,000, has been incorporated to manufacture and sell galvanic batteries, portable electric lamps, etc. W. S. Baker, B. H. Ottinger and J. C. Ottinger are the promoters.

**The Boonville Electric Light and Power Company,** of Boonville, Ind., with a capital stock of $10,000, has been incorporated to manufacture and furnish electric and other lights, etc. L. J. Miller, S. B. Hatfield and C. M. Hammond are connected therewith.

**The Electric Supply and Engineering Company,** of Detroit, Mich., capital stock $25,000, has been organized to manufacture electrical machinery and goods. The incorporators are Wm. H. Fitzgerald, Wm. C. Clark and Frank C. Teal, all of Detroit, Mich.

**The Akron Electric Light, Heat and Power Company,** of Akron, O., with a capital stock of $300,000, has been started to supply electricity for light, heat and power, etc. Ira M. Miller, H. H. Crowther, A. S. Hanscom, R. P. Barnett and C. H. Loomis are the incorporators.

**The Green River Coal and Coke Company,** of Seattle, Wash., capital stock $1,000,000, has been started to erect and operate electric light works, etc. J. H. Bryant, Jos. E. Cox, of New York, N. Y.; A. S. Dunham, Wesley Wilson and John Craig, of Seattle, Wash., are the incorporators.

**The Waseca Light and Power Company,** of Waseca, Minn., with a capital stock of $50,000, has been formed to operate a plant for generating and furnishing electricity for light, heat and power. The incorporators are L. P. Ordway, F. L. Benjamin and Frank Benjamin, of St. Paul, Minn.

**The Fairbury Electric Light and Power Company,** of Fairbury, Neb., capital stock $30,000, has been organized to furnish electric light and power, and to act as electrical engineers, etc. H. E. Chubbuck, Fred. W. Allen, Frank Dungan, Sam W. Schweitza and R. B. Howell, of Fairbury, Neb., are the promoters.

**The White Bear Electric Company,** of White Bear, Minn., with a capital stock of $10,000, has been formed to construct, maintain and operate a plant for furnishing electricity for light, heat and power, etc. The promoters are H. M. Byllesby, G. C. Duffie, W. P. Johnson, B. F. Meek, Jr., and H. C. Levis, all of St. Paul, Minn.

**The Nebraska Power Company,** of Omaha, Neb., with a capital stock of $250,000, has been started to own, control, sell and lease certain inventions by Whitcomb L. Judson, and to construct street railways in towns in Nebraska and Council Bluffs, Ia., power to be supplied by means of said inventions and patents. J. A. Creighton and Lewis L. Reed are the incorporators.

**The Noblesville Light and Ice Company,** of Noblesville, Hamilton County, Ind, capital stock $25,000, has been organized to construct and operate an electric light and ice plant to manufacture and furnish electric light and power to Noblesville, and for manufacturing ice and supplying cold storage. J. L. Peck, S. J. Peck and Geo. S. Christian, all of Noblesville, are the promoters.

**Sprague, Duncan & Hutchinson (Limited).**—Incorporated in Florida; principal office in New York City. Capital stock, $50,000. This company has been incorporated for the promotion, construction, management, purchase, sale, etc., of electrical undertakings and securities of all kinds and such other business as may be incidental thereto. Frank J. Sprague, Alfred Bishop Mason and Cary T. Hutchinson are the organizers.

## AFFAIRS OF THE COMPANIES.

**The Mexican Telephone Company's** November rentals were $6,070, an increase of $550 over 1890. The number of telephone instruments in use has increased from 1,098 to 1,203 in a year.

**Westinghouse Electric Directors** will meet, it is reported, Jan. 6 to consider the preferred dividend question. A declaration for the time elapsed since the stock is issued at the fixed rate per annum is hinted at as possible.

**Great Falls, Mont.**—A dividend of $1 a share has been declared by the Boston & Great Falls (Montana) Electric Light and Power Company, payable Jan. 1 to stock of record Dec. 28. This is one of several Great Falls enterprises controlled by Boston capital, and the first of the list to declare a dividend.

**Stockholders of the American District Telegraph Company,** of New York, will hold a special meeting on Jan. 12, to vote on a proposition to increase the capital stock from $3,000,000 to $4,000,000, and also, it is stated, to ratify and approve a recent deal between the Mutual District Messenger Company and the Mutual District Telegraph Company.

**The First Mortgage Gold Bonds** of the Richmond Railway and Electric Company are to be offered for sale by Messrs. John M. Davis & Co., of New York. The authorized issue is $2,000,000. Of this amount $700,000 is reserved to be issued and certified by the trustees for future extensions and betterments, leaving the amount standing $1,300,000, with an annual interest charge of $65,000. The net earnings in 1890 were $90,656. The net profits from operation for ten months of 1891, from Jan. 1 to Oct. 30, were $100,592, or more than 50 per cent. in excess of the interest charge for the entire year.

**The Northwest Thomson-Houston Electric Company** some time ago increased its capital stock to $750,000, all the capital stock at that time being fully paid in. As some erroneous statements have been circulated regarding the company's finances it is now authoritatively stated that since then further amended articles have been filed increasing the capital stock from $750,000 to $1,500,000—the last $750,000 being preferred stock. Of the preferred stock $400,000 has been subscribed and paid for at par, which with the $750,000 of common stock heretofore paid in in full makes the actual cash capital at this time, irrespective of surplus, $1,150,000. The remaining portion of the preferred stock, that is, $350,000, has been subscribed and will be fully paid as soon as the time expires for making payment on it.

# Special Correspondence.

## NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-177 TIMES BUILDING, NEW YORK, Dec. 28, 1891.

**Mr. H. M. Kibbie** obtained from the National Electric Light and Construction Company of New York a franchise for an electric lighting and power plant for the town of Oyster Bay, L. I., at Glenwood, Oct. 15, 1891.

**H. J. Smith,** the genial operating superintendent of the New York Edison Company, was presented with a handsome diamond pin by the attachés of the company Christmas Eve. "Smithie" is not only an able manager, but a good fellow of the first magnitude.

**Mr. Frederic Duggan,** proprietor of The Imperial Porcelain Works, Trenton, N. J., was in the city this week closing up contracts for 1892. The products of The Imperial Porcelain Works seem to be giving every satisfaction to those of the electrical fraternity using them.

**The Magnetic Club.**—Notice is hereby given that the annual business meeting of the Magnetic Club will be held in Room 29, 195 Broadway, on Thursday, Jan. 14, 1892, at 5 P. M., for the election of officers and four members of the governing committee, and such other business as may properly come before the meeting. The date of holding the next social meeting is under advisement of the Governing Committee, and will be announced soon.

**Paterson, N. J.**—Those present at the station of the Edison Electric Illuminating Company on Saturday witnessed a very pretty sight when the new compound engine of 250 h. p., built by the Ball & Wood Company, was started. Little Elizabeth Brock, four-year-old daughter of the general manager of the company, after some climbing successfully reached the throttle valve, and, exerting all her strength, gave it a twist which threw 2,500 more lights into the dark places of the city.

**The Monthly Record** is the title of a very neat eight-page pamphlet issued each month by the Edison General Electric Company. It has special reference to the railway branch of the business. The second number is handsomely printed and contains many news items and facts that are of interest not only to railways operated by the Edison system, but to all interested in electric traction. Both in literary merit, arrangement and typography it is excellent, and indicates great newspaper talent in its editor, Mr. C. W. Dever, of the railway department. Mr. Dever, of course, gives most of his time to other work; but his efforts in the direction we have indicated are worthy of a veteran.

**The Trolley System Adopted.**—As was stated in the last issue of THE ELECTRICAL WORLD, the Board of Aldermen of Brooklyn has authorized three of the street railway companies of the city to substitute electricity for horses, namely, the City Railway Company, the DeKalb and the Brooklyn and Coney Island companies. Thus ends a prolonged fight against "the trolleys" in Brooklyn. The permit gives the roads the right to substitute electric power, known as the "single trolley," and to construct, erect and maintain all the necessary poles and wires for the transmission of electric currents for the propulsion of cars on all streets and avenues on which the different companies' lines now run. The regulation provides that the poles shall be of iron and steel not less than 20 feet in height, and that the companies give bonds to the amount of $150,000, subject to the approval of the Mayor and Corporation Counsel, to indemnify the city for any damages done. On the final vote the resolution was carried 13 to 4, only four aldermen voting in the negative.

**American Institute of Electrical Engineers.**—The following resolution passed by the International Congress Committee and the Council of the American Institute of Electrical Engineers is the outcome of the recent visit to New York City of Dr. Elisha Gray, of Chicago, chairman of the Committee on the World's Electrical Congress. Dr. Gray, after several informal interviews with officers and members of the Institute, was invited to attend a meeting of the Congress Committee on Dec. 16, where a mutual exchange of views upon the subject was had, and so far as is known the result is entirely satisfactory to all parties interested. "*Resolved*, That the American Institute of Electrical Engineers, having already taken action during the past three years, by correspondence and otherwise, toward the holding of an International Electrical Congress in connection with the Columbian World's Fair, hereby expresses its desire and intention to co-operate, by all means in its power, with the World's Congress Auxiliary of the World's Columbian Exposition, through its Electrical Congress Committee, in furthering the gathering of such a congress at Chicago in 1893, and in making it a successful and worthy representation of the best electrical science and practice in all parts of the world." L. H. H.

## PHILADELPHIA NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
927 CHESTNUT STREET, PHILADELPHIA, Dec. 26, 1891.

**Queen & Co.** have moved their electrical department from 924 to 1010 Chestnut street, Philadelphia.

**Churchman & Co.,** of Philadelphia, whose trade was much affected by the McKinley bill, are again looking up.

**Horn, Brannen & Forsyth,** Philadelphia, are manufacturing some very handsome designs in the electrolier and combination fixtures line.

**The Barr Pumping Engine Company,** Germantown Junction, Philadelphia, report business for their various makes of pumps as being good.

**E. E. Houghton & Co.,** of Philadelphia, who are well known in the electrical field as furnishing lubricating oils, report increased sales for their product.

**Novelty Electric Company,** Philadelphia, report the call for their wire gauge still growing. In their special lines, and Xmas novelties, trade has been brisk.

**The Camden Thread Company,** of Philadelphia, who manufacture silk and cotton thread for insulated wires, have pleasant things to say regarding business.

**James Reegan & Co.,** Filbert street, Philadelphia, report business in the grate line as being good. They are receiving several inquiries relative to their sand bell, and it is noticeable that many are from street railway companies.

**Warren, Webster & Co.,** 491 North Third street, Philadelphia, are making strenuous efforts to fill all orders now in by the close of the year. They have done a large volume of business this year, and expect to add numerous customers during the coming one.

**Star Electrix Company,** Philadelphia, are still vigorously pushing the manufacture of their different lines in anticipation of a reaction in general business with the commencement of the New Year. The Star Electrix Company show no small amount of enterprise at all times.

**The Accumulator Company to Continue Business.**—In the case of the Brush Electric Company vs. the Accumulator Company, Hon. Edw. T. Green, Judge of the United States Circuit Court at Trenton, yesterday issued an order permitting the Accumulator company to supply its customers with storage batteries until the further order of the Court, and fixed the date for arguing the case on its merits for Jan 7. This is the case in which it was erroneously stated that perpetual injunction had been issued.

**The Rapid Transit Problem.**—The question of rapid transit for Philadelphia is getting warm, and as the traction company has signified its intention of adopting electricity on some of the lines, it has drawn out several articles from local papers. The current feeling seems to be for the storage battery. One paper quotes, as an example of the feasibility of such a system, the successful running of storage battery cars in Washington. Notwithstanding what the newspapers say, however, the traction company will be governed by the experience that is abundantly furnished by the many cities throughout the country using electric power, and Philadelphia may be assured that their decision will be for the general good.

**The Lease of the People's Passenger Railway Company** to the Traction Company, referred to in our last issue, has been consummated. It is looked upon as a gigantic deal and it is understood that the contract is for 999 years, and embodies every owner and controller with the exception of the Lombard & South Street Railway companies. The People's Passenger Company has a capital stock of $275,000. There is a bonded debt of $750,000. It is stated that probably the most interesting sequel of the big deal will be the construction of an electric road from 13th and Chestnut streets out to Ogonz. The Traction Company will increase its capital stock from $6,000,000 to $8,000,000 and probably to $10,000,000, the limit.

**Electricity for the "Dark Continent."**—Mr. Wm. Malcolm, of Cape Town, South Africa, is visiting this city in the interest of a syndicate, having for its object the introduction of a thorough electric system into that country. He is now examining into the merits of the different makes of dynamos, motors and storage batteries, and is also inquiring as to the trolley and other systems of electric propulsion. He also proposes to visit the various plants in Philadelphia, preparatory to making his report to the gentlemen he represents. Mr. Malcolm states that up to the present time all efforts to introduce electrical apparatus in Africa have been under the direction of Germans, who have been in the habit of charging exorbitant prices. He also states that the only method of lighting now in vogue is by gas, which, as elsewhere, is found to be inadequate to the demands. W. R. W.

## NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 28, Hathaway Building, 620 Atlantic Ave.,
BOSTON, Mass., Dec. 26, 1891.

**The Consolidated Electric Manufacturing Company** is making a very nice holiday exhibit in its new show rooms, corner Congress and Franklin streets, Boston.

**The Whitney Instrument Company,** Manchester (N. H.), reports business as being exceedingly brisk. This is very gratifying, as the company has only recently begun manufacturing.

**The Bradbury-Stone Storage Battery Company,** Lowell, is turning out some very nice designs of storage battery in cabinet and other portable shapes for sewing machines, dental lathes, etc.

**The Boston Braid Company** is making a superior silk for incandescent lamps, and it is evident that it is appreciated by lamp manufacturers, as some of the largest companies are using it and all speak in its favor.

**The Berlin Iron Bridge Company** has just placed in position what is said to be the largest girder in the world. It spans the Mattabessett River at East Berlin. It is 102 feet 6 inches long, 6 feet deep, and weighs over 50 tons.

**The Belden Mica Mining Company,** Boston, is mining a remarkably clear article, which is said to be much liked by elec-

trical people who have used it. The company can furnish any quantity either in bulk or cut to any size desired.

**The National Telephone Manufacturing Company,** Boston, sells outright a mechanical telephone which is said to be of excellent quality. Some of the installations within the past week or two are those for the Oliver Ames & Sons Corporation; the Sewall & Day Cordage Company, Hon. W. A. Beard, Collector of the Port; also additional lines for the Old Colony Railroad. Estimates have just been furnished for the New Hampshire Insane Asylum.

**New England Electric Club.**—A party of electrical people met at the Tremont House Wednesday night and elected the following officers: Ferdinand W. Wyman, president; E. A. Record, vice-president; L. M. Hayes, secretary; A. O. Smith, treasurer; Chas. C. Pierce, Maybin W. Brown, Elmer P. Morris, directors. The new club starts off under very favorable auspices with a membership of 110. An adjourned meeting is to be held January 5, to perfect arrangements for rooms, location and various other details.

**New Street Railway Supply Station.**—The immense field which the street railway has opened up to electricity, and the hundreds of roads already operated by this new method, have created a market for railway supplies quite as important, if not more so, than any other branch of the industry. This new market has added an impetus to the supply business that is most gratifying, and the first large manufacturing company to take advantage of it is the Thomson-Houston Electric Company. This company has recently opened a supply department in connection with the railway department at the Boston headquarters, where it carries a line of supplies including everything from a trolley insulator to a generator. Arrangements have been completed whereby all the branch offices will keep in touch with the business in different parts of the country, so that all orders will be promptly attended to. In addition to supplying the roads using its own system, the company will accommodate roads using other systems—in fact, is ready to supply the entire street railway business.

## WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
465 THE ROOKERY, CHICAGO, Dec. 26, 1891.

**Mr. A. D. Adams,** formerly with C. J. Thomson, of St. Paul, is now with the Jenney Electric Motor Company, of Indianapolis, Ind.

**Mr. Frank A. Yeakle,** the electrical contractor of Riverside, Cal., has just completed some excellent wiring in New Riverside residences.

**Mr. O. B. Conover,** of the John A. Roebling's Sons' Company, Chicago, secured some nice orders in Minneapolis and St. Paul this week.

**E. W. Blatchford & Co.,** 70 North Clinton street, Chicago, are supplying the trade with sheet fuse metal of correct proportionate carrying capacity.

**The Western Electric Company,** of Chicago, is having an excellent trade in its Phœnix dry battery, which has proved so efficient under exhaustive tests.

**The Consumers' Electrical Supply Company,** of Tacoma, Wash., is in the market for the handling of specialties in the far West, and manufacturers should open correspondence.

**The Weisel & Viller Manufacturing Company,** Milwaukee, Wis., has installed several Corliss engines in electric lighting and street railway plants during the past three months.

**The Nubian Iron Enamel Company,** Cragin, Ill., is supplying street railway companies with a high grade enamel for use on its electric heaters and wherever metal is exposed to intense heat.

**The H. Dudley Coleman Machinery Company,** Magnolia and Erato streets, New Orleans, La., reports a steady demand for steam plants and a prospective business far exceeding that of last year.

**Mr. George A. Weymouth,** of the Perfect Pencil Pointer Company, Portland, Me., called on Chicago customers this week in the interest of one of the best and most convenient articles for office use ever introduced.

**Mr. Carl Kammeyer,** superintendent of the National Electric Manufacturing Company, of Eau Claire, Wis., was one of the interested participants in the discussion of the subject of rapid transit at the Club on Monday evening.

**Cribben, Sexton & Co.,** 55 Erie street, Chicago, are supplying electric heater manufacturing companies with a white porcelain finish that is said to stand intense heat and that is well adapted for use on other forms of electrical apparatus.

**Mr. Leslie W. Collins,** late manager of the Chicago office of *Electricity* and formerly with the *Electrical Review*, the *Western Electrician*, and manager of the Chicago Electric Club, has removed to New York and joined the advertising staff of the *Electrical Engineer*.

**Mr. La Fayette Cole,** the traveling representative of Holmes, Booth & Haydens, has secured some handsome orders in the Puget Sound country, one from the Consumers' Electrical Supply Company, of Tacoma, Wash., including a carload of the well known K. K. insulated wires.

**Albuquerque, N. M.**—The Electric Reduction Company, which was recently organized in this place, has already contracted for machinery. This is to be in the nature of an experimental plant, and should it prove as successful as the projectors anticipate the company will erect extensive works.

**St. Cecilia's Church,** on Forty-fifth street, Chicago, was dedicated on Sunday last by Archbishop Feehan. The church was handsomely decorated and the interior brightly illuminated by several hundred incandescent lamps. The entire electrical work was done by W. L. Popple & Co., 407 The Rookery, Chicago.

**Curve Grease.**—Street railway companies in almost every State in the Union are using Graphite curve grease and strongly indorsing its economical qualities, and while the Wadhams Oil and Grease Company, of Milwaukee, has supplied some fifty different street car lines with its curve grease, not one word of complaint has been received.

**The Consolidated Temperature Controlling Company,** of Minneapolis, Minn., is already in correspondence with many parties who appreciate the advantages arising from the use of the automatic valve recently illustrated in THE ELECTRICAL WORLD, especially in office buildings, where it can be quickly installed and will automatically insure an equable temperature.

**The Electrical Engineering and Supply Company,** with headquarters in St. Paul and branches in Chicago and Duluth, has issued a circular letter calling attention to the gratifying increase in the volume of business during the year, and states: "We now have a building fitted up especially for our use, with all the latest improvements, including an electric elevator, and are prepared to handle goods more promptly than ever from a large and complete stock."

**Mr. S. B. Fowler,** of the Standard Underground Cable Company, is rapidly completing its extensive contract in Minneapolis, and in laying the cable underground is applying his new form of terminal protector wherein the terminals of the double conductors are drawn through the capped end of a rubber sheath and the surrounding space then filled with an insulating compound (poured through a hole in the cap) effectually preventing the absorption of moisture.

**Mr. James W. Johnson,** manager of the Western isolated lighting department of the Thomson-Houston Electric Company, is sending out one of the most attractive advertisements seen for some time. A large lithographed representation of the Masonic Temple on State street, having the space represented by the glass cut out, is placed within a frame with a second glass behind the lithograph. Within the frame and behind the second glass four incandescent bulbs are placed, and when the current is turned on the effect is charming.

**Window Decorations.**—Artistic window decorations are the rule at this season of the year, but one window that is peculiarly attractive to young and old alike is that in the supply house of Julius Andrae, Milwaukee, Wis, Entwined among the branches, which are supporting suitable presents, are nearly a hundred miniature incandescent lamps of various colors the lighting features of which are enhanced by the dark velvet background. Then holly and mistletoe placed around white porcelain shades add to the decorative effects. It is gratifying to know that although the cost of so attractive a display was not small, it has been returned many fold by the publicity given and the orders for work of a similar character in the windows of other houses. F. DE L.

LINCOLN, Neb., Dec. 24, 1891.

**The Nebraska City Electric Light Company** has gone into the hands of a receiver. D. P. Rolfe has been appointed.

**The Thomson-Houston Electric Company** is endeavoring to get a franchise for lighting the town of Fairbury, Neb.

**C. K. Chubbuck,** of Tecumseh, Neb., was in the city recently, purchasing supplies, poles, etc., for increasing the plant at that place.

**Mr. C. P. Rutty,** representing the McCreary Electric Supply Company, of New York, passed through Lincoln recently. He reports business as being very good in his line.

**F. G. Daniel,** of the Short Electric Railway Company, has fitted up the show window of Hallowbush in a very attractive manner. The word "Short" is spelled out and pronounced by the make and break contact of the different lamps.

**The Sioux City Electrical Supply Company,** under the management of H. O. Woodruff, reports the following recent sales: Sioux City Engine Works, 225-light plant; Northwestern Spice Company, 20-h. p. motor; Evans Block Electric Elevator, 15-h. p. motor; W. F. Widman, 5-h. p. motor; Water Bros., printers, 4-h. p. motor; Ivy Building, 500-light plant; Booge Hotel, 500-light plant.

**The Lincoln Electrical Manufacturing and Supply Company** reports the following sales for the month ending Oct. 31: Seiler Dairy Company, 5-h. p. motor; Hunter Printing Company, 3½-h. p. motor; Knowles, Huckins & Thomas, 1-h. p. motor; Leis Sewing Machine Emporium, ½-h. p. motor; Harpham Bros., ½-h. p. motor; J. Herrick, restaurant, ½-h. p. motor; Capital Hotel, 1-h. p. motor; Lansing Opera House, 3-h. p. motor. H. A.

## SOUTHERN NOTES.

NORFOLK, Va., Dec. 26, 1891.

**Radford, Va.**—The Radford Street Railway Company will build an electrical railroad.

**Childs, Md.**—An electric light plant will be put into the paper mill of C. S. Garrett & Sons.

**Blountville, Tenn.**—An electrical railway is contemplated between Blountville and Bristol.

**Lynchburg, Va.**—The Rivermont Street Railway is authorized to erect an electric light, heat and power plant.

**Baltimore, Md.**—The South Baltimore and Curtis Bay Railroad Company has increased its capital stock to $100,000.

**New Berne, N. C.**—It is probable that the Electric Street Car Company will extend its lines to Pollocksville and Trenton.

**Mobile, Ala.**—The City Council advertises for bids to erect an electric lighting plant of 200 arc lights for the use of the city.

**Velasco, Tex.**—Preparations for lighting the streets by electricity are now going forward rapidly. The capacity will be for 800 lamps for a short while.

**Petersburg, Va.**—The Petersburg Street Railway Company will change from horse power to the overhead electric system, and add two miles of track.

**Beaumont, Tex.**—The buildings of the Beaumont Ice, Light and Refrigerating Company will be enlarged by an addition, 60 by 100 feet, and other improvements will be made.

**Richmond, Va.**—The committee on electric lights of the City Council invites bids for furnishing the city with from 300 to 500 electric lights, of 2,000 c. p., for two and four years.

**Catonsville, Md.**—An electric light plant to be operated by water will be erected by the new company, comprising the names of W. J. Dickey (president), John Hubner, J. M. Cone and others.

**Paragould, Ala.**—The Paragould Electric Light and Power Company has been incorporated, with C. Wall, W. C. McDonald, M. F. Callier and A. Bertig, for the purpose of erecting an electric light plant. The capital stock is $6,000.

**Kissimmee, Fla.**—Surveyors report that work will be commenced at once, constructing the telegraph line to Juniper, to connect there with a cable to the Bahama Islands, thence to England This line to Juniper will be finished in 15 days.

**Fayetteville, Tenn.**—A controlling interest has been purchased in the ice factory, lately consolidated with the Fayetteville Electric Light Company, by H. K. Bryson, J. H. Holman and G. W. Morgan New machinery will be put in and other improvements made.

**Savannah, Ga.**—The Postal Cable Telegraph Company has completed its line from Savannah to Charleston, direct by the country roads, instead of following the railroad. To do this it was necessary to lay a cable across the Savannah River, requiring 1,500 feet of cable.

**Chattanooga, Tenn.**—The electric car company construction shop, under the superintendency of Alderman John Stewart, is building cars 24 feet long in the inside. They are made of the old horse cars, by splicing two together after removing the partitions in one end. They will be used on the St. Elmo line.

**Portsmouth, Va.**—A charter has been applied for to build and operate a railway from Port Norfolk to Portsmouth. Electricity will probably be used. Capital stock is to be from $10,000 to $500,000. The corporators are: M. W. Mason, of Norfolk; W. H. Stewart, of Portsmouth; Reid Carpenter, of Mansfield, O., and others.

**Lynchburg, Va.**—The Rivermont Street Railway Company has petitioned for a charter, with Peter J. Otey, C. M. Blackford, W. H. Dulaney and others, as corporators. The company is privileged to construct and operate a street railway using horse, steam, electric or other motive power. Capital stock from $30,000 to $200,000.

**Richmond, Va.**—A bill has been introduced in the legislature to charter the Portsmouth Electric Railway Company. Incorporators are: Virginius Butt, C. S. Sherwood, J. W. H. Porter, A. J. Phillips and Edward Mahoney. The company is authorized to construct and operate an electrical railroad. Capital stock is from $10,000 to $100,000.

**Street Railway Measures Introduced in the Senate.**—Several measures have been introduced in the Senate that are of local interest in the District of Columbia. Senator Plumb introduced a bill to incorporate the Washington and Great Falls Electric Railway Company, with W. Codd, Jas. F. Morrison, of Maryland; Jas. L. Barber, Jas. Robbins, Smith Pettit, John G. Slater, Edwin Baltzler, J. P. Clark, B. De F. Jennings, C. B. Cottrell, of the District of Columbia. The overhead system is to be used. A bill was introduced by Senator Plumb to incorporate the Washington and Bennings Street Railway Company. The incorporators are William B. Thompson, George O. Glavis, Norval W. Burchell, Jona H. McGowan, Horace J. Gray, Charles M. Swift, George B. Sheriff Andrew J. Curtis, Isaac Sharp and Milton P. Caldwell, of the District of Columbia, and James T. Perkins, of Springfield, Md.

**El Paso.**—The strike of telegraph operators between El Paso and Yuma, on the Pacific system of the Southern Pacific Railroad Company, promises to develop into mammoth proportions. The superintendent of the Santa Fé railroad ordered dispatchers to handle Southern Pacific trains between this city and Deming, N. M., but the operators bluntly refused to do so, and the superintendent was notified. If he tries to force the matter, and puts "scabs" to do the work, it means a strike on the whole Santa Fé system. The district superintendent of the Western Union ordered the men to handle the trains between here and Deming, but the men would not, and the matter rests there until higher officials are heard from. In an interview one of them stated that if the Southern Pacific Company succeeded in defeating the strikers, they would be next to be dealt with in a like manner. The operators have received assurance from every connection and they will stand by each other in this case. V. N. B.

## ENGLISH NOTES.

LONDON, Dec. 21, 1891.

**Nottingham.**—The Town Council of Nottingham has decided to go in for electric lighting, and to spend some £30,000 as a commencement.

**Board of Trade and Overhead Wires.**—Electric Light contractors have recently received an intimation from the Board of Trade that that department cannot in future allow overhead wires to be run anywhere as a permanency. As a consequence of this announcement the electrical industry, headed by Mr. Compton, is getting up a petition to the Board of Trade, pointing out that this simply amounts to a prohibition of electric lighting and electric traction enterprise in rural districts.

**The Theatrophone in London.**—The "theatrophone," which is in plain English merely a nickel-in-the-slot telephone connected to a theatre, was tried on Tuesday evening at the Savoy Hotel. Theatrophones have, I believe, become quite the rage in Paris, all the fashionable clubs and restaurants being fitted with them. At the trial last night connection was only made with the Savoy Theatre, a few yards away; under these conditions the music of the opera was of course heard, with all imaginable clearness and loudness. How the idea will answer under normal conditions of London fog and wet and induction from Wheatstones, "tickers" and similar disturbers of telephonic lines remains to be seen.

**A Proposed New Standard of Light for London.**—For some time past something like a wrangle has been going on between the London County Council and the Board of Trade with regard to the appointment of a committee to consider the advisability of adopting a more scientific standard of light for gas-testing purposes than a spermaceti candle burning 120 grains per hour. The County Council wouldn't and the Board of Trade couldn't provide the necessary money. A *deus ex machinâ* has now appeared in the shape of the South Metropolitan Gas Company, which has undertaken to pay all the expenses of a scientific and practical committee of ten, nominated by the London gas companies, the Board of Trade and the County County. It is to be hoped that this committee's deliberations will lead to the adoption of a standard of light which will commend itself alike to the practical electrical engineer and gas engineer and to the professor in his laboratory, since whatever standard this committee advises the Board of Trade to adopt for London will probably be made the universal and legal standard for the British Empire. Each country has its own standard of morals, which is at times rather puzzling, and if each town in the United Kingdom were to be allowed to have its own standard of light photometry would become even more empirical than it is at present.

**London County Councils and Overhead Wires.**—At the meeting of the London County Council on Tuesday it approved a set of by-laws in connection with overhead wires in the metropolis, drawn up in pursuance of the London Overhead Wires Act of 1891. As all overhead wires in London will in future be governed by these by-laws, it may be perhaps interesting to your readers to see what sort of regulations it is proposed to enforce. Within three months of the approval of these by-laws by the Board of Trade, every company owning overhead wires will have to supply full particulars with regard to them to the London County Council and to every vestry through whose district they pass, for the purpose of registration and identification, these particulars to be accompanied by a plan. In future any company proposing to erect an overhead wire will have to give notice to every local authority concerned 14 days beforehand and obtain their several permissions. No wires are to be of a less height than 20 feet above the ground, or where crossing a street at a less height than 25 feet. No span (unless special permission is given) is to exceed 115 yards, and no wire is to cross the street at a sharper angle than 60 degrees. The factor of safety for all conductors and all suspended wires is to be at least 5 and for every support at least 10, the maximum possible wind pressure being taken at 50 lbs. per square foot. Every support is to be marked in such a manner as to enable County Council inspectors to identify it at once, and all new supports are to be stamped with the date of their erection. Cables have, without exception, to be carried by independent suspending wires, and are not to exceed 1 inch in diameter and 1 lb. per lineal yard in weight. The County Council, I may add, define a cable as follows: "Any covered or insulated wire, when the thickness of covering or insulation exceeds the diameter of the wire and any number of insulated wires combined in one cable whether stranded or separate." Every metal support is to be connected to earth, and every non-metal support is to have a lightning conductor. Any contravention of these by-laws will render the offender liable to a fine of £10, with an additional fine of £2 for each day the offense is continued after conviction.

## CANADIAN NOTES.

VICTORIA, B. C., Dec. 16, 1891.

**Westminster, B. C.**—The Baptist Church has recently been fitted up with an electrolier, and electric lights will be used throughout.

**The Edison General Electric Company's Staff** were over from Portland and wired the Five Sisters Block. A No. 12 Edison is to be placed when the building is finished.

**New Ball Plant.**—The B. C. Agricultural Association has placed one 50-light Ball arc and one 150-light Ball incandescent machine in its new building. Weiler Bros. have also placed a small Ball dynamo in their furniture factory.

**A Line Inspector.**—The City Council are about to appoint a line inspector. He is to be allowed to inspect all building on behalf of the insurance companies as well. There is an agitation for all wires in the busy part of the town to be put under ground.

**Nanaimo, B. C.**—Two electric arc machines have recently been started and are giving the best of satisfaction, and the town is one of the best lighted in the Northwest. Edison representatives have been busy for the past four months equipping mines at this place, and expect to have the work finished shortly.

**Mr. J. E. Winslow** has resigned his position as chief of the lighting department of the N. E. T. and Lighting Company. He has gone to England to take charge of the Leeds E. R. R. under Messrs. Laing, Wharton & Co., London, England, operators of the T.-H. system. Mr. Swanstrome has been appointed as his successor.

**Two Edison cars** will be put on the electric road in January. Two new branches of the electric railroad will soon be opened to Spring Ridge and Mount Tolmie. The Spring Ridge cars have just arrived from the Brill company, of Philadelphia. They are 35 feet long, and set on two trucks with four wheels to each. The motors are of the S. R. G. type from the Westinghouse Works and are of 25 h. p. These are without exception the finest cars yet landed on this island.

**Increase of Lighting Facilities.**—An immense cross compound engine of 500 h. p. is being placed by the Goldie & McCulloch Engine Company, of Galt, Ontario, Canada, in the new station of the N. E. T. & L. Co. for the lighting department. This company's success in the lighting department has been quite phenomenal. One Excelsior arc and one T.-H. alternator are to be placed in the new station along with the machines already in the first building. The power and lighting departments will then be entirely separate.

# News of the Week.

## THE ELECTRIC LIGHT.

**Cannon Falls, Minn.**—Several parties are negotiating for the erection of an electric light plant.

**Augusta, Me.**—The Kennebec Light and Heat Company has recently added a new 1,300-light dynamo to its station.

**Brunswick, Md.**—The electric light and power house has been totally destroyed by fire. Estimated loss, $10,000.

**Mascoutah, Ill.**—The city is now lighted with electricity. There are 50 street lights and upward from 200 commercial lights.

**Ely, Minn.**—A movement is on foot to secure a franchise for a private company, for the purpose of erecting an electric light plant.

**Crawfordsville, Ind.**—It is stated that the capacity of the city electric light plant will have to be increased in order to meet the demand for increase in service.

**Wheeling, W. Va.**—It is stated that the Board of Gas Trustees is considering purchasing the incandescent plant of the Wheeling Electric Company. The price asked for the same is $84,000.

**F. P. Little & Co.,** of Buffalo, have just contracted with W. H. Walker & Co., of that city, to install a 250-light Thomson-Houston dynamo and a Rice engine in their new building on Pearl street.

**Norfolk, Va.**—The government has completed a contract with the Thomson-Houston Electric Company to erect an electric light plant at the Norfolk Navy Yard, work on which will begin at once.

**St. Louis, Mo.**—The Municipal Electric Light and Power Company, it is stated, has decided to throw up its contract to light the city of St. Louis, unless given $125,000 per year more than it is now receiving.

**Ann Arbor, Mich.**—The new 650 light incandescent dynamo for the Thomson-Houston Electric Company is being put in place, and when in operation the plant will have a capacity of 1,500 incandescent lights.

**Dayton, Tenn.**—The City Council, at a recent meeting, contracted with Messrs. Burk, Halter & Gibson to erect an electric light plant, the city agreeing to take 12 or more lights for the same, at a rate of $120 per month for 10 years.

**Long Island City.**—The Board of Aldermen has passed a resolution giving a contract to the Long Island City Electric Light Company to light the principal streets and avenues of the city for the next five years, at $160 per light per year.

**Valparaiso, Ind.**—An action has been filed in the Circuit Court to enjoin the city from fulfilling the contract entered into between the City Council and the Stratton Electric Light Company, the legality of the contract being called into question.

**Bowling Green, O.**—Mr. E. H. McKnight and others, who have recently purchased the electric light plant, have organized the Bowling Green Electric Light and Power Company, with Mr. McKnight, president; S. J. Miller, secretary, and Joseph Schauer, treasurer.

**Vulca wire ducts** have recently been placed in the following residences and other buildings in the West and elsewhere: Whitelaw Reid's new residence, the Dixon Crucible Works, Wausau Court House, Wausau, Wis.; Pabst Hotel, Milwaukee; Maus Office Building, Indianapolis. These installations were made by the New York Insulated Wire Company, whose system of interior conduits for wiring is meeting with admirable success.

**The East River Electric Light Company** has filed with Comptroller Myers, through Henry B. Trombley, 80 Broadway, New York, a claim for $500,000 damages to its property and business, caused by the cutting down of its poles and wires in December, 1889, by order of Mayor Grant. The claim made is that the damage was unauthorized by law; also that many wires and poles, legally erected, and in streets where there were no subways, were cut down, although the wires were perfectly safe and properly insulated, and that the investment of the company was thus rendered worthless and its overhead franchise practically destroyed.

**The New Edison Electric Light Station** referred to in our last issue as being in contemplation in Chicago, it is stated, will be the largest electric light illuminating establishment in the world. The north and northwest parts of the city will be lighted from it. The company has now the largest electrical illuminating station in the world, furnishing from 50,000 to 60,000 incandescents and about 500 arc lights. It is stated that the new station will have a capacity of 5,000 to 10,000 h. p., and will furnish from 100,000 to 150,000 lights. Speaking of the new station, R. C. Clowry, one of the directors of the company, recently stated: "Chicago and its people are nothing if not progressive. We must be with them. It is true that we have yet plenty of room and power to spare in the central station, but we want to forestall the needs of this growing city. The business of our company has been increasing at a great rate and it has been decided to make ready for a general adoption of electric lighting all over the city."

**The Badger Electric Company,** of Racine, Wis., has one of the finest plants in the State. The Thomson-Houston system of arc and incandescent lighting is used. The company has recently added new dynamos and engines, and in the near future, it is stated, expects to have a power circuit to supply current for electric motors. The company has over 3,000 incandescent lights in use. Referring to the success of this company an exchange recently had the following: Much of the credit for the enterprise and push of this company is due to its popular manager, Mr. P. H. Korst. Mr. Korst came to Racine several years ago as the representative of the Thomson-Houston Company and took charge of the Racine plant. His experience and good management were soon apparent and were felt in the community, the patrons of the company recognizing at once his ability and urbanity. A year ago Mr. E. C. Deane, a stockholder of the Badger Electric Company, was elected president, which office he has filled to the satisfaction of patrons at well as stockholders. No corporation in the city is more ably and economically managed and none more worthy of encouragement and patronage than the Badger Electric Company.

## THE ELECTRIC RAILWAY.

**Des Moines, Ia.**—An electrical railway 23 miles in length, it is stated, is to be built to connect Indianola with Des Moines, costing $250,000.

**Electric Lines for Yonkers.**—The Common Council of Yonkers has voted in favor of the Yonkers Street Railway Company changing its system to an electrical one.

**To Have Electric Traction.**—The Jersey City Board of Street and Water Commissioners has passed an ordinance allowing the Jersey City & Bergen Railway to construct electric lines.

**Rochester, N. Y.**—At a recent meeting of the directors of the Rochester Electric Railway it was decided to increase the power at the Charlotte power house by equipping it with new engines and dynamos. It is expected that the work will be completed before the first of May.

**Proposed New Electric Railway.**—The probable construction of an electric railway along the pikes connecting Dayton, Medway, New Carlyle and Springfield, O., is reported. Another project, it is stated, is on foot to run an electric line from Dayton, O., down the Miami River to Mill Creek, and thus into Cincinnati, a distance of about 55 miles. It is stated that engineers are now at work locating the proposed line.

**Electrical Motors to Propel Its Trains.**—It is stated that the Illinois Central Railroad Company is likely to be the pioneer road in putting electrical power into use for drawing heavy railroad trains. At a recent meeting of the board of directors J. W. Doane and Norman Ream were appointed a committee to investigate and report upon the feasibility of having all trains entirely propelled by electrical power. The cause of this action is said to be due to the strong opposition in the city of Chicago to the smoke and smut resulting from the use of bituminous coal.

**Helena, Mont.**—The Helena, Hot Springs & Smelter Railway Company, controlling eight miles of track and three steam dummies, has recently been consolidated with the Union Electric Railway Company, of Helena, running between Helena and Lenox, a distance of two miles. The consolidated lines are being equipped throughout with electrical apparatus, the Thomson-Houston system being used. This equipment will include three Thomson-Houston generators, six waterproof motors and car equipments, and three 125-h. p. Russell engines with boilers to correspond.

**The four electric railway companies** in Brooklyn, which have been authorized by the Board of Aldermen to substitute the electric trolley system for horse power seem to be confident that there will be no obstacles offered to their plans. It is stated that the estimated cost of the changes will be $8,500,000. The City Railroad Company's estimate of the cost of the change on all its lines is $6,000,000, while President Richardson of the Atlantic avenue road places the cost to his company at $1,500,000. The cost to the other two companies, the Brooklyn City & Newtown and the Coney Island & Brooklyn, will foot up about a million.

**Shenandoah, Pa.**—The construction of the M. C. S. G. & A. Street Railway is being pushed forward rapidly. The power house, which will be 90 × 50 feet and constructed of stone, will be when completed one of the finest in that section of the country. The power plant will consist of two 250-h. p. Corliss engines and four 62,000-watt Thomson-Houston generators. The boiler plant will be in a separate building located in the rear of the engine room, and will contain six 100-h. p. return tubular boilers. The line when completed will be 18 miles in length. Mr. C. R. Eberle is general manager of the road and Mr. H. H. Scholl is his assistant. Mr. A. W. Gilbert is superintendent of the construction for the Thomson-Houson Electric Light Company, of Philadelphia, and has charge of that company's work in the installation of the plant.

**The Washington (Pa.) Electric Street Railway Company** controls some three and one-half miles of track and has been running four cars, each carrying two Westinghouse 20-h. p. motors, since April, over heavy grades averaging 7½ per cent. It is doing a splendid business and is giving entire satisfaction to its numerous patrons. Much of the credit of this enterprise from a financial and commercial point is due to Mr. James Wilson, the president and general manager, as well as to Sam Ewing, the secretary of the company. It is currently reported that the company will extend its line east of Washington over the famous National road as far as the Laboratory, two miles out, and as far west as Tylerdale, one and one-half miles, where the large establishment of the Tyler Tube Company is situated. A number of cars will be added at an early date.

**Electric railways at Sacramento, Cal.,** were recently referred to in the following manner by one of our Sacramento exchanges: During the past year a great deal has been accomplished by the Electric Street Car Company. A good many miles of road have been equipped, and at the present time the company has in service about 22 miles of electric line running in various directions throughout the city, and recently the company has acquired by purchase the horse car lines that constituted formerly the entire street car system of the city. These lines will at once be equipped with electricity, and in the very near future Sacramento will be as well supplied with electric roads as any other city on the coast. In fact, the projectors of the enterprise claim that it will be the best equipped city west of Chicago. The Board of Trade takes especial satisfaction in calling attention to this improvement, because of the active part taken by it in securing the inauguration of the enterprise.

## PERSONALS.

**C. H. McKee,** of Pittsburgh, was in this city yesterday in connection with the agreement between the Philadelphia and Pittsburgh traction interests in the Smoky City.

**Mr. F. Napier Denison,** of the Edison General Electric Company, Toronto, on account of ill-health, leaves this week for a three months' trip to the Mediterranean and its adjacent countries. He will combine business with pleasure and visit some of the principal electric stations on the Continent.

## LEGAL NOTES.

**The Brush Electric Company** has filed three additional suits in the United States Circuit Court against Mandel Bros., George H. Williams & Co. and Frank Bros., of Chicago, alleging that these three firms are using arc lamps that are infringements of patents owned by the complainant company. The lamps are of the double carbon variety and are made by several electric light companies in Chicago.

**A judgment of foreclosure and sale** has been granted by Judge Pratt in the suit of Henry D. Donnelly and John Englis, trustees for first mortgage bondholders, against the Brooklyn, Bushwick and Queens County Railroad Company. The bonds were for $250,000, the greater part being held by the Englis family, and the amount of the judgment is $284,795. The road is to be bought in by a committee of the bondholders, who have asked for leave to adopt the trolley system. The line runs from the Broadway ferry, through Kent and Metropolitan avenues to Middle Village, with a branch to Canarsie.

## Industrial and Trade Notes.

**F. B. Platt,** of the Electric Supply Company, Ansonia, Conn., has just returned from an extended business trip through New York and Ohio.

**The Hickory Electric Company,** of Hickory, Pa., calls attention of manufacturers to the fact that there is no such concern located in that city as the "White Hall Electric Company."

**The Ball Engine Company,** of Erie, Pa., has found it necessary to arrange for further extensions of its works. The increase of business in the last six months has been unprecedented.

**Chas. Ward, of Charleston, W. Va.,** manufacturer of boilers, in a competitive test was granted by the Navy Department a contract for building four marine boilers, as the Ward marine boilers were found to be superior to any other boilers offered for test.

**The Hunt Engineering Company,** of 126 Liberty street, has found business so good that it has been compelled to add to its office room and force in order to keep up with its work. The energy and ability of this firm are becoming thoroughly appreciated in electrical circles.

**Extending Their Works.**—The large and increasing business done by the Crocker-Wheeler Electric Motor Company, New York, has several times made it necessary, during the year just closing, for it to secure more room for manufacturing purposes. The company reports that it has again taken additional space in the buildings occupied by it at 430-432 West Fourteenth street, and will put in considerable more machinery.

**Among the enterprising firms** now doing electrical construction work of the very best character, is that of Putnam, Gay & Co., of Rochester, N. Y. They have a large business, and seem to be constantly busy. Among recent installations may be found the Mackey Building, 600 lights, Western Electric System; American Brewery, 200 lights, also Western Electric system; C. H. Vochell's Big Elm Stock Farm, 75 lights, illuminating all the out-buildings, barns, etc. This hustling concern is also agent for the Interior Conduit and Insulation Company.

**F. Holman & Co.** have opened a large office at 128 Pearl street, this city, where they will handle electrical specialties, paying particular attention to the sale of the well known "Paradox" reflector shades. These are made with metal top and ground glass bottom, and have been christened the "Paradox" shades because they at once concentrate and diffuse the light. This ingenious device was invented by Mr. F. Holman, and was first placed on the market by the Edison General Electric Company, meeting with a large sale. The present manufacturers expect to make these shades of different designs and shapes to meet the requirements of the trade.

**The Electric Appliance Company,** of Chicago, is meeting with splendid success in introducing the New England switch to the Western trade and already reports large sales. The company has inaugurated what we think a new departure in the electrical supply-business; that is the publishing of a catalogue especially devoted to toys and novelties for the holiday trade. About Dec. 1 the company printed quite an elaborate little catalogue of this character, which it has distributed all over the country through the medium of the young people's periodicals and which is bringing in quite a valuable trade. The Electric Appliance Company certainly deserves credit for this original idea in placing before the people in general an opportunity of securing reliable electrical toys and novelties in the electrical line.

**The Ball Engine Company,** of Erie, Pa., manufacturers of automatic cut-off engines, report the following recent shipments: Lawrence Gas and Elec. Light Company, of New Castle, Pa., one 150-h. p. single cylinder engine, one 80-h. p. to the Attica Electric Light Company, of Attica, N. Y.; one 150-h. p. to the Citizens' Electric Company, of Braddock, Pa.; to the Youngstown Electric Light Company, of Youngstown, O., one 350-h.p. cross compound; and one 50-h. p. single cylinder to the Pittsburgh & Birmingham Traction Company, of Pittsburgh, Pa.; to the California Eectric Light Company, of San Francisco, one 300-h. p. cross compound; to the Claremont Electric Light Company, one 80-h. p.; one 200-h.p. to the Johnston Electric Light Company, of Johnston, Pa.; one 100-h. p tandem compound to the Abington & Rockland Electric Light Company, of North Abington, Mass.; two 50-h. p. single cylinder to the Edison General Electric Company, of New York; to the Union City Electric Light Company, of Union City, Tenn., one 80-h. p.; one 35-h.p. to the Brush Electric Light Company, of Cleveland, O.; to the Loraine Electric Light Company, of Loraine, O., 100-h. p.

**Weston Measuring Instruments at the Frankfort Exhibition.**—It may be remembered that the Weston Elec-

trical Instrument Company, of Newark, N. J., decided at the last moment to exhibit its Weston standard portable ammeters and voltmeters and other electrical measuring instruments at the Frankfort Electrical Exhibition. In taking this course the company was well aware that its instruments would be subjected to close scrutiny by many of the most competent and eminent electricians and electrical engineers of Europe, and would be brought into direct competition with those made by such prominent firms as Siemens & Halske, Hartmann & Braun and other makers of high grade instruments. The Weston Electrical Instrument Company, however, felt great confidence in the merits of its goods, and was certain that if the instruments were thoroughly examined and tested, their great accuracy, permanency, portability and convenience would commend them to the favorable notice of the European electricians and engineers, and that it would be able to secure many orders for them. Recent developments show that the confidence of the manufacturers in the merits of the Weston instruments was not too great. The company has received most favorable notice in many of the German scientific journals, and, what is more important, numerous orders for its voltmeters and ammeters from many of the best electrical engineering firms in Germany and other countries, including Siemens & Halske, Ganz & Co., Shuckert & Co., Lahmeyer & Co., Allegemeine Elektricitäts Gesellschaft, the Societa Generale Italiana di Elettrecita and the Brush Electrical Engineering Company. It has also received orders from many of the most distinguished electricians of Europe, notable among whom are Prof. H. F. Weber, of Zurich; Prof. Kittler, Prof. Kolhrausch, Prof. Perret and Prof. Lichtheim. Prof. Weber was a member of the testing commission of the Frankfort Exhibition, and had an opportunity of thoroughly examining the merits of the Weston instruments. The instruments sent to Frankfort were not specially made for exhibition purposes, and, as a matter of fact, it is said, were not equal to those sent out daily in the regular course of its business. This arose from the fact already stated, that the company did not decide to exhibit in Frankfort until about the time the exhibition was to open, and all the available space had by that time been taken by other exhibitors. Room was secured, however, by the Exhibition Committee building, an annex expressly for the Weston Electrical Instrument Company. The time required to prepare for so extensive an exhibit of the many varieties and ranges of its instruments, and the numerous parts entering into their construction, was necessarily very short. In addition to this the Weston company was greatly pressed with orders at the time, and was engaged in largely extending its facilities for manufacturing and standardizing the instruments. It was, therefore, extremely difficult to get out a sufficient number of the instruments to properly represent the work of the company. Under these circumstances it was impossible to spend the time necessary to secure close adjustment of the instruments intended for exhibition, without greatly interfering with regular commercial work. The Weston Electrical Instrument Company feels justified in expecting a still more favorable reception of its instruments after the filling of the numerous orders already received; because if the relatively poor ones sent as an exhibit were so favorably received, it is fair to suppose that those of its usual standard quality will be still more appreciated.

## Business Notices.

**Complete Equipment** of electric light and power plants with the Mather system. Also agent for the Perkins' incandescent lamp. E. T. Pardee, 14 Butler block, Syracuse, N. Y.

**Battery Cut-Out, Cheap.**—Sensitive, reliable, never requires attention. Gas-lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

# OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

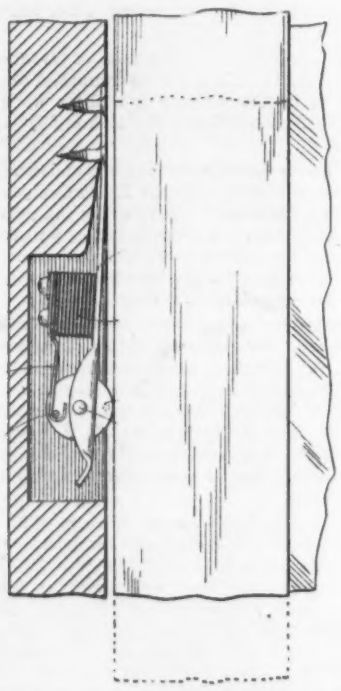
### U. S. PATENTS ISSUED DEC. 22, 1891.

**456,444. Electric Switch**; Henry Barton, of London, England, Assignor to John Abbott Iliffe, of same place. Application filed Dec. 15, 1890. A locked electric switch comprising a laminated spring brush, centrally and freely suspended upon a vertical spindle and bent downward from its support at an approximate angle of forty-five degrees, an actuating handle, a locking spring, a locking arm, an unlocking arm, a turning spring, and terminal cylindrical contacts, the spring brush co-operating with the inner cylindrical face of the contacts.

**465,447. Guard for Trolley Wire Insulators**; Francis O. Blackwell, of Lynn, Mass. Application filed May 29, 1891. A guard for electric railway trolley wires, consisting of a lug or projection formed on the trolley wire holder at a distance from the point of support of said holder.

**465,469. Electric Railway Trolley**; Charles Foster, of Whitesborough, N. Y. Application filed May 31, 1890. The combination, with a trolley head having a trolley wheel, of movable wheels which, in connection with the head and trolley, are adapted to surround the conductor.

**465,501. Train Signaling Apparatus**; Paul Synnestvedt, of Chicago, Ill. Application filed Oct. 13, 1890. The combination, in a train signaling apparatus, of an electrically operated compressed-air signal, with an electric circuit extending therefrom through all parts of the train and through a suitable battery provided thereon, circuit-breakers included in said circuit and adapted to be operated by signal-cords provided in the coaches, a main compressed air reservoir, a low pressure reservoir and reducing valves consisting in a piston adapted to operate in the cylinder, an upper chamber containing the pin valve adapted to be closed against the seat provided therefor in the end of the pipe extending from the main reservoir, a pipe leading to the chamber and a pipe communicating therefrom with a cylinder beneath the piston, whereby a constant and comparatively low pressure is maintained in the reservoir for use in sounding the whistle.



No. 465,602.—Electric Circuit Closer for Burglar Alarms.

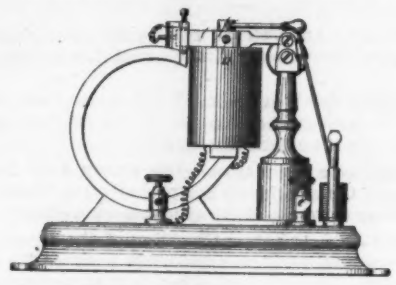
**465,508. Cut-Out for Incandescent Lamps**; Herbert C. Wirt, of Boston, Mass. Application filed March 28, 1890. The combination, with an incandescent lamp, of connecting device having two concentric terminals respectively connected with the terminals of the lamp, with an insulating piece interposed between said concentric terminals and a cut-out spring connected to one of said concentric terminals and separated from the other by a film of insulating material, one of said terminals inclosing and protecting the cut out spring.

**465,511. Electric Snap Switch**; William S. Andrews, of New York, N. Y., Assignor to the Edison General Electric Company, of same place. Application filed May 7, 1891. The combination, in a switch or circuit breaker, of a base, terminals mounted on it and extending perpendicularly therefrom, a switch arm pivoted to one of the terminals and movable in a plane at right angles to the base, a handle pivoted to the same terminal and movable independently of the switch arm, a spiral spring connecting the handle and switch arm, means for positively communicating motion from the handle to the switch arm after the former has made a partial movement, and a second terminal in position to co-operate with the switch arm.

**465,512. Rheostat**; William S. Andrews and Alfred K. Warren, of New York, Assignors to the Edison General Electric Company, of same place. Application filed Aug. 25, 1891. The combination of an electric motor, a fan driven thereby, a guard for the fan, and a switch at the centre of the guard for controlling the motor.

**465,514. Electric Arc Lamp**; Henry Price Ball, of Brooklyn, Assignor to the Edison General Electric Company, of New York, N. Y. Application filed June 13, 1891. The combination, with a cut-out circuit for an arc lamp having main and shunt coils, of a circuit controller for the cut-out circuit, moved by the shunt coil or magnet, a resistance in the cut-out circuit sufficient to divert current to the main magnet to re-establish the arc when the carbons come together, a catch or lock in position to engage and hold the controller when moved by said coil or magnet, and means controlled by said main magnet for disengaging the catch or lock.

**465,548. Annunciator for the Supposed Dead**; William H. White, of Topeka, Kan. Application filed Nov. 24, 1890. An improved grave-annunciator comprising a suitable coffin or receptacle for the body, a circular plug fitted into an aperture in the coffin, a cylindrical tube having a flanged lower end secured to the circular plug, screw-threaded externally at its upper end and inclined outwardly and upwardly at the upper part of its interior, a tube internally screw-threaded at its lower end to embrace the first named tube, a perforated cap screwed upon the upper portion of the second tube, a disc journaled horizontally in the upper portion of the second tube, a bracket secured vertically in one side of the second tube, a sliding rod mounted vertically in the bracket and held upwardly by a surrounding coiled spring and also notched at its lower end, a spring-detent secured to the inner surface of the second tube and engaging the notches of the rod, a rod connecting the disc with the sliding rod, a fixed contact spring secured to the bracket and connected to the line wire, a movable



No. 465,809.—Electrical Testing Instrument.

contact carried by the sliding rod and operating by engagement with the upper end of the fixed contact-spring to close the circuit, and a wire connected to the lower end of the sliding rod and designed to be attached at its lower end to the body within the coffin or receptacle.

**465,564. Conduit for Electric Wires**; Henry W. Johns, of New York. Application filed April 1, 1891. A conduit for electric wires, composed of strips of compacted asbestos fibre wound in opposite directions, and waterproofing material and cementing material.

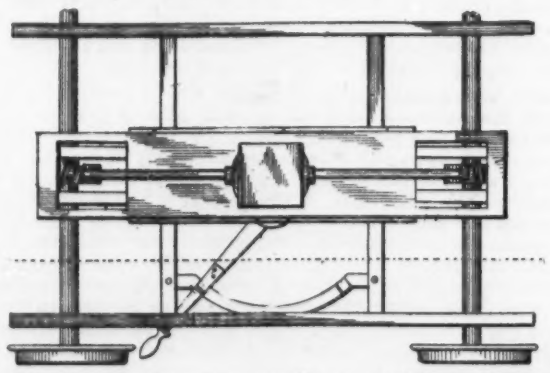
**465,592. Gearing for Electric Motor Cars**; Owen F. Evans, of Columbus, O., Assignor of one-fourth to William H. Slade, of same place. Application filed Jan. 24, 1891. In a gearing for electric motor cars, the combination, with a suitable truck frame, truck wheel axles, and worm gear wheels carried thereby, of a rocking motor support centrally fulcrumed upon the truck frame, a motor support upon said rocking plate, a motor shaft extending from opposite ends thereof, and a worm carried by each end of said motor shaft, and means for so tipping said motor support as to cause one of said worms to gear with one of the wheels. (See illustration.)

**465,594. System of Electrical Distribution**; Frederick A. La Roche, of Philadelphia, Pa., Assignor to the La Roche Electric Works and George H. Earle, Jr., of same place. Application filed Oct. 9, 1890. The combination, with a pair of sources of electricity, of a lead electrically connected to and connecting the positive poles of said sources of electricity, and a lead connected to and connecting the negative poles of said sources of electricity and following substantially the same path as the lead connecting the said positive poles but in a reversed direction, and translating devices electrically connected between the leads at various points thereon between the points of electrical connection thereof with the sources of electrical energy.

**465,602. Electric Circuit Closer for Burglar Alarms**; William C. Thompson, of Minneapolis, Minn., Assignor to the Western Electric Company, of Chicago, Ill. Application filed Oct. 19, 1889. A circuit closer consisting in the combination with a spring carrying a roller, of a hook insulated therefrom, a lateral pin provided upon the roller and adapted to be brought against the hook to close the contact therewith when the roller is rotated in one direction, and a stop in the path of the pin for limiting the movement of the roller. (See illustration.)

**465,613. Electric Railway**; William H. Applegate, of Atlantic, Ia., Assignor to the International Electric Railway Company, of Chicago, Ill. Application filed Nov. 10, 1890. In an electric railway, an underground connector extending parallel with a track and having contact points or brushes connected therewith at intervals to extend horizontally, and a car carrying a flat sided conductor, with its broad faces extended vertically and at right angles to the contact points or brushes, connected with the underground conductor to operate in the manner set forth.

**465,618. Electric Switch**; Gwynne E. Painter, of Baltimore, Md., Assignor of one-half to James F. Morrison, of same place. Application filed April 16, 1891. An electric switch consisting of a base plate, a rocking lever supported upon a base having its axis



No. 465,592.—Gearing for Electric Motor Cars.

parallel to the surface of said plate, a detent engaging one end of said lever, a contact piece or pieces carried by its other end, but insulated therefrom, for making and breaking an electric circuit, and spring push buttons extending through the plate to operate the said lever.

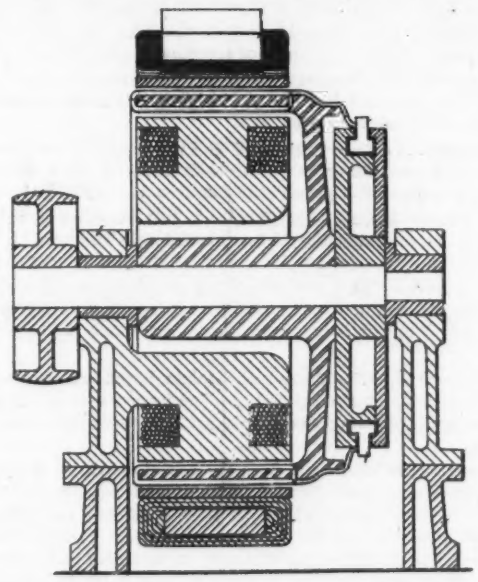
**465,648. Combined Signal and Telephone System**; Thomas W. O'Brien, of Wilkes-Barre, Pa. Application filed July 20, 1891. The combination, with an annunciator system consisting of two or more signaling instruments at a central station and two or more keys at different subsidiary points for transmitting signals through subsidiary conductors by closing the circuit of a common generator, of a key having a resting contact and a working contact for transmitting signals, and a switch whereby the resting contact of said key may be placed in connection at will with a branch including a signaling instrument or with a branch including a speaking instrument.

**465,655. Independent Electric Clock**; Walter J. Dudley, of Somerville, Mass. Application filed July 11, 1891. The combination of time measuring vibrator, its impelling device and restoring electromagnet and armature therefor, a second lever independent of said impelling device pivoted near the centre of suspension of and engaged by said time measuring vibrator, and a circuit closer for said electromagnet independent of but normally jointly controlled by said impelling device.

**465,684. Incandescent Electric Lamp Fixture**; Gustave E. Villaret and Victor E. Rondel, of Philadelphia, Pa. Application filed May 23, 1891. A fitting for an electric fixture, consisting of a plate with a central opening and raised lugs and an annulus having recesses in its inner periphery, arms connected with said annulus, and a socket on said arms, the arms being set out from the annulus, forming a chamber rearward of the socket, with spaces between the sides of said arms and opposite portion of the inner periphery of the annulus, the long diameter of the plate being less than the short diameter of the annulus.

**465,685. Electric Arc Lamp**; Henry C. Waldecker, of Austin, Minn., Assignor to Winfield S. Pierce, of same place, Samuel H. Pierce, of Hudson, Wis., and Harry F. Batchelor, of Miles City, Mont. Application filed April 8, 1891. In an electric arc lamp, the combination, with the upper carbon carrier thereof, of a fluid containing tube, a hollow piston, fitting closely in said tube and provided with an upwardly opening gravity valve, said piston having a cap provided with one or more fluid passages or apertures, a pulley, and a cord connected to said piston and to the said carbon carrier and passing over said pulley, whereby as the said carbon carrier starts to descend any sudden movement thereof will be checked by the suction of the said piston in its tube, and whereby, also, the said piston will be free to descend through the fluid inclosed in the said tube.

**465,778. Adjustable Support for Telephones**; Charles H. Gatchell, of Fredericton, Canada, Assignor of one-half to Albert James Gregory, of same place. Application filed Aug. 26, 1891. The combination, with a telephone, of a hinged arm having its free end bifurcated, a vertically adjustable rod adapted to hold and support a telephone receiver, passing through apertures in said bifurcations, and a coiled spring encircling said rod, located intermediate of and bearing against said bifurcations.



No. 465,808.—Dynamo-Electric Machine.

**465,805. Means for Turning on and off Electric Currents**; Thos. Carpenter Smith and Benjamin D. Acker, of Philadelphia, Pa., Assignors to Isaac C. Walker and Henry G. Kepler of same place. Application filed Oct. 1, 1890. In combination with the permanent terminals of two line wires of opposite polarity, companion conductors located between said terminals and embodying a series of interruptions, movable conductors at each interruption which maintain two conductors on one side of a given interruption in connection alternately straight and cross with the two conductors on the other side of said interruption, each permanent terminal being in circuit with one and out of circuit with the other of the adjacent pairs of conductor sections of the series.

**465,806. Electric Railway Trolley**; Frank J. Sprague and Patrick F O'Shaughnessy, of New York, Assignors to the Sprague Electric Railway and Motor Company, of same place. Application filed Jan. 22, 1889. The combination, with an electric railway car, of a contact device, a pole carrying said contact device, a transverse bar carrying said pole, a single horizontally placed spiral spring, both ends of which engage said bar but on opposite sides of said bar, and a stationary support for said spring.

**465,808. Dynamo-Electric Machine**; René Thury, of Geneva, Switzerland. Application filed Aug. 4, 1891. A multipolar dynamo-electric machine or generator comprising two concentric rows of field magnets disposed the one within the other and having the unlike poles of the magnets of the respective in juxtaposition, a rotatable armature composed of a divided hollow thin iron cylinder mounted between said row of magnets and provided on the inner face with internal axially disposed conductors, and connections at the respective bases of the armature for coupling up said conductors from pole to pole. (See illustration.)

**465,809. Electrical Testing Instrument**; Richard Varley, Jr., of Englewood, N. J. Application filed Jan. 15, 1891. A testing instrument comprising a polarized armature supported in a magnetic field with a normal bias toward one pole, a coil for creating a bias toward the other coil, and an electromagnet actuated by the armature when shifted under such change of bias to impel it toward its initial position, whereby a continuous vibration of the armature is maintained during the passage of current through the coil. (See illustration.)

*Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1886—can be had for 25 cents. Give date and number of patent desired and address The W. J. Johnston Co., Ltd., Times Building, N. Y.*